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you see more efficiently

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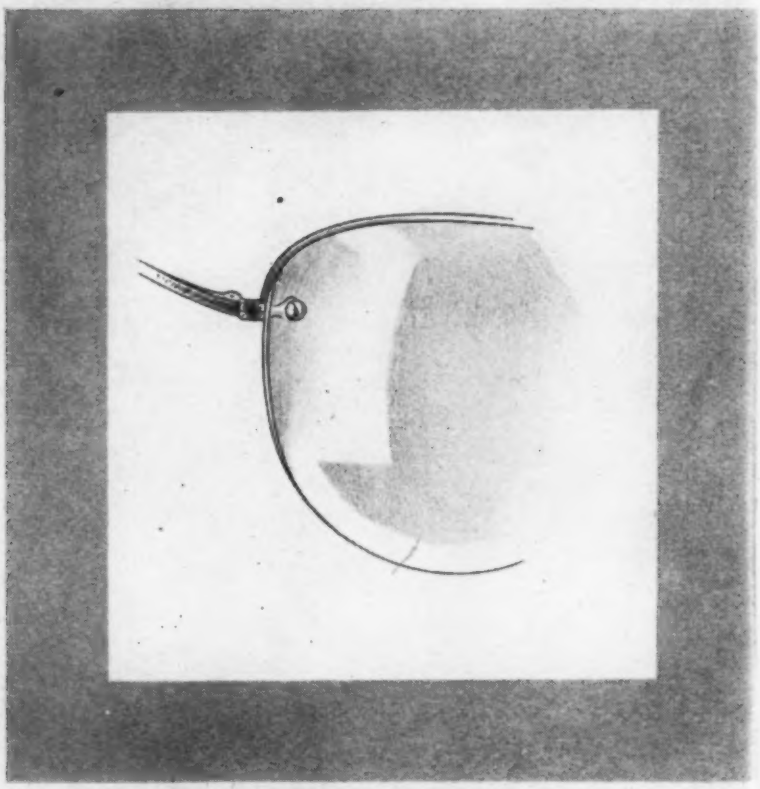
TO SEE WELL...

BAUSCH & LOMB



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DO YOU sometimes wish your arms were longer so that you could read the fine print of a telephone book or a time-table? Does your nose get in the way of your hand when you dial? Do you have trouble reading your penciled memoranda and shopping lists?

The telephone often serves a useful purpose for which it was not designed. It tests eyesight. Telephones and their accessories are made for people with normal eyesight or for eyesight made normal by proper care and correction. If you can't read the fine print of the telephone directory, don't blame the print. Blame your eyes. If you can't see the dial letters and numbers, don't blame the telephone. Blame your eyes.

It is amazing how well we manage to fumble along under ordinary conditions with poor eyesight. We grow so accustomed to seeing poorly that we think we see well. Then when we try to read or distinguish something a little bit difficult and fail, we blame everything but our eyes.

Take these difficulties as warnings. Have your eyes examined promptly. Get the best that eye science has to offer—through the professional services and skills of the Ophthalmologist or Optometrist, the technical training of the Ophthalmic Dispenser (Optician). At the first sign of difficulty, get professional help for "the only pair of eyes you will ever have". The comfort, efficiency, and downright pleasure of good eyesight are priceless.

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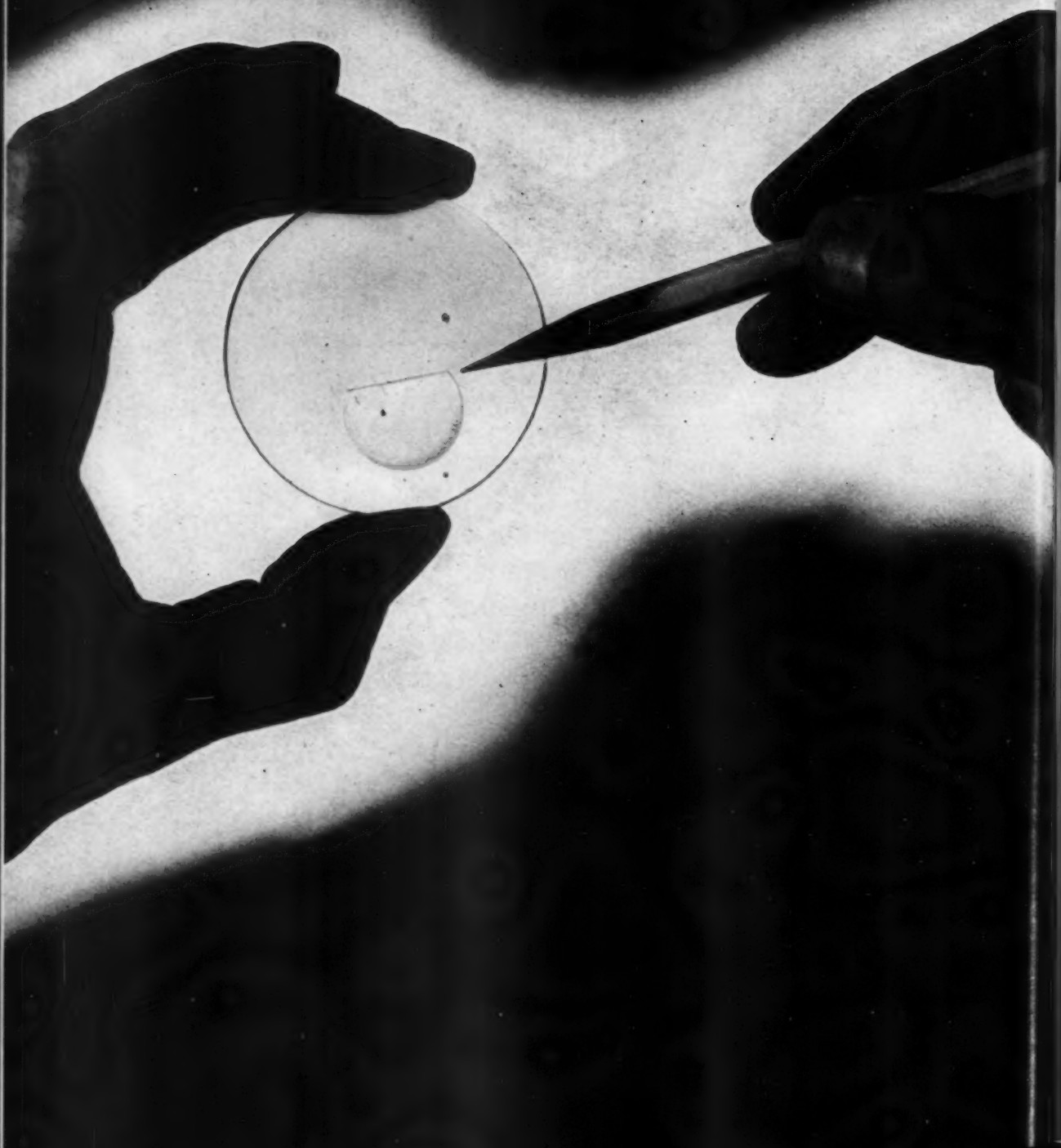

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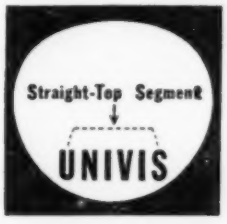

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2-Way* and 3-Way* Lenses

UNIVIS

Precision That Knows No Compromise

ADJUNCTO STRAPS

Give Double Protection Twice!

ONE: the frame retains its shape . . . it cannot bend away from the lens.

TWO: the lens mount screws remain firm, lenses are permanently fixed . . . they won't wobble.

Adjuncto Straps affixed to Arcway 996 illustrated above.

And this double protection from ADJUNCTO STRAPS works in two ways. To the wearer of Arcway or Numount frames, it means added safety and greater convenience. Because no amount of rough handling can distort these frames once they are permanently *locked* with ADJUNCTO STRAPS. To you, it means saved time and trouble. Once you have fixed ADJUNCTO STRAPS on your patient's glasses, he won't be coming in again and again for adjustments.

Give your patients and yourself the full advantage of this double protection of ADJUNCTO STRAPS.

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to Supplement Office Care

Send for this Valuable Bulletin

☆ *It's Informative* ☆ *It's New*
☆ *It's Illustrated*

There is no fundamental difference between *properly supervised* home training and training in the office.
Our home training manuals detail specific routines, which the doctor should discuss with the patient, and then carefully check with him on his subsequent visits to the office.

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Meadville Penna
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Please send me your new bulletin
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. . . but she can still have cool vision with THERMINON'S *Two-Way* protective lenses!

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Your patients can enjoy the sun . . . yet guard against glare and heat with THERMINON'S TWO-WAY protective lenses for *cool* and *safe* vision.

For heat-free protection
PRESCRIBE THERMINON

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CORPORATION
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AO's 19th Educational Messa

PIONEERING FOR PROFESSIONAL ADVANCEMENT

This full-page educational message will appear in the May 28 issue of LIFE, the August 21 issue of LOOK, the August 25 issue of THE SATURDAY EVENING POST and GOOD HOUSEKEEPING for month of September

DEDICATED TO THE ADVANCEMENT OF PROFESSIONAL EYE CARE

Public Misconceptions
—about Crows
—about Glasses

"AS THE CROW FLIES" IS NOT ALWAYS A STRAIGHT LINE

GLASSES ALONE CAN'T CORRECT FAULTY VISION

When a man uses the expression "as the crow flies," he's using a handy phrase for the shortest distance between two points. Actually, however, the crow is an erratic flier. He often varies his flight with sudden swoops and dives. To think that a crow's flight means literally a straight line would be a misconception.

There's another misconception which is far more serious. It's the notion that you can correct faulty vision merely by "buying a pair of glasses." It's exploited by certain merchandisers who blatantly advertise "bargain glasses" and "eyes examined free." The implication is that glasses are the primary factor, and that examination is so unimportant that it can be given away.

That's wrong.

Glasses are important, of course, but your eye comfort and visual efficiency depend upon proper professional care. That means a careful examination and a great deal more; your eyes must also be refracted, your glasses prescribed, your prescription interpreted, your glasses fitted, re-evaluated and serviced.

It is for these professional services that you pay a fee.

Glasses, alone, cannot correct faulty vision. What counts most is the professional skill and the technical services of your Ophthalmologist, Optometrist, Ophthalmic Dispenser.

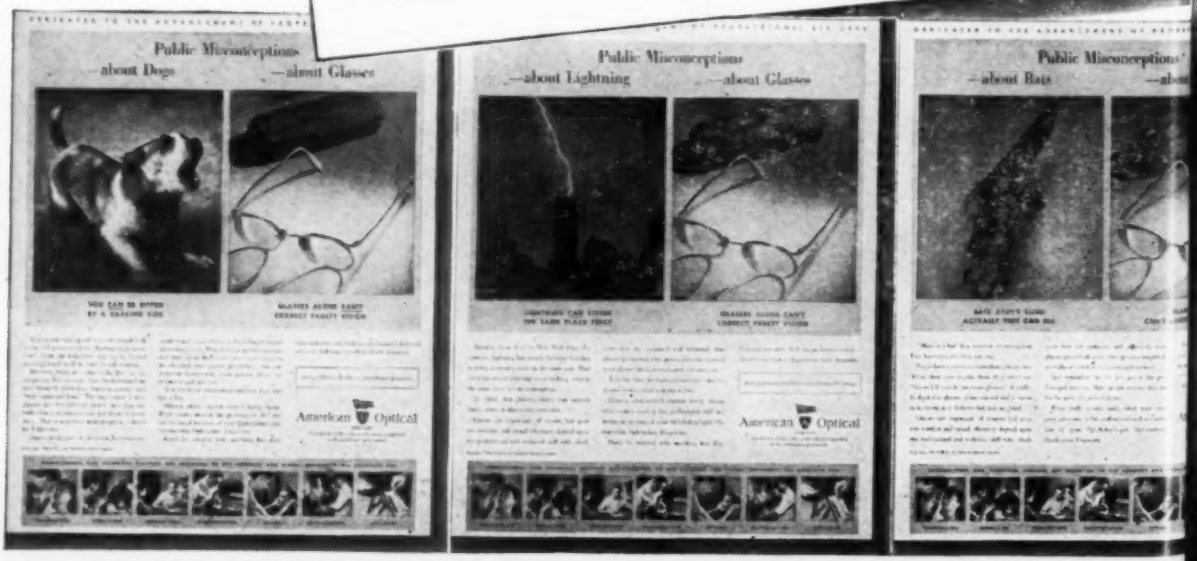
Don't be satisfied with anything less than thorough eye care. Seek the professional skill and services that your priceless vision demands.

Seek professional advice—not glasses at a price.

American Optical

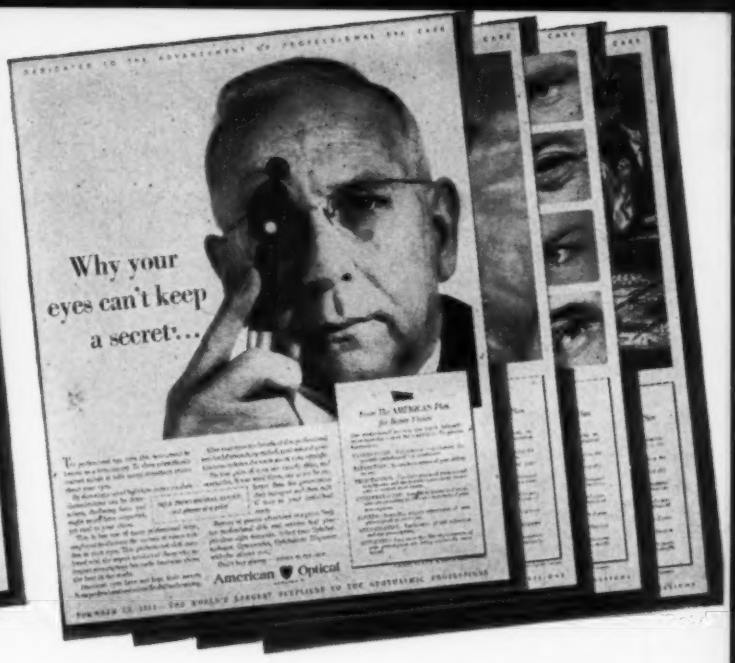
PROFESSIONAL AND TECHNICAL SKILLS ARE ESSENTIAL TO EYE COMFORT AND VISUAL EFFICIENCY—Use AMERICAN Plan

EXAMINATION · REFRACTION · PRESCRIPTION · INTERPRETATION · FITTING · RE-EVALUATING · SERVICING


Public Misconceptions
—about Dogs
—about Glasses

Public Misconceptions
—about Lightning
—about Glasses

Public Misconceptions
—about Bats



Originating the campaign to correct the public misconception regarding the relation of spectacles to eye care and visual efficiency, AO continues its pioneering advertising with its 19th message exclusively dedicated to the advancement of professional eye care.

In national magazines—LIFE, LOOK, THE SATURDAY EVENING POST and GOOD HOUSEKEEPING—AO messages time after time have driven home the fact that in eye care, professional skills and technical services are factors of prime importance and that materials are of value only when professionally prescribed. This is still the theme of AO national advertising.

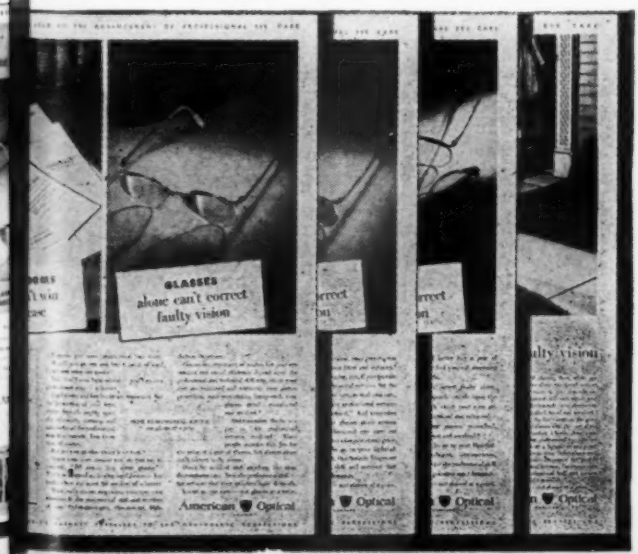
First messages of AO's unique educational series pointed to the professional progress in eye care since the old days of spec peddlers and glasses by mail. Then came the series which pointed out that medical, dental, and legal materials, like ophthalmic materials, are of no benefit without professional application.

This year, AO educational messages feature popular misconceptions about bats, lightning, barking dogs, and crows comparing them to the misconceptions regarding the proper relation of glasses to eye comfort and visual efficiency.

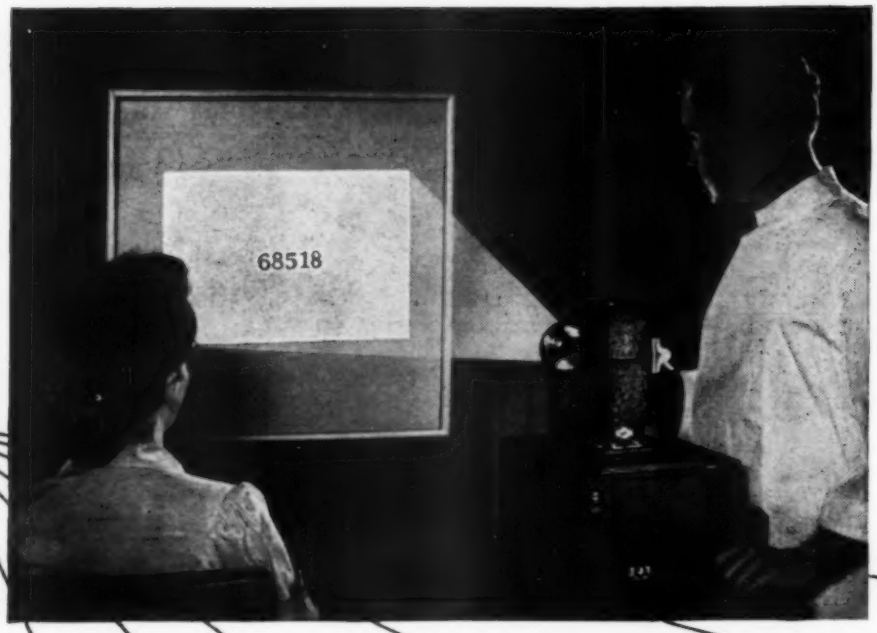
Written in the interests of professional progress, these AO messages exclude all reference to ophthalmic products.

AO's nineteenth and newest educational message continues in the campaign dedicated to the advancement of professional eye care.

American Optical
COMPANY



TODAY'S SPECIALS
Instruments alone can't perform a tonsillectomy—
nor, glasses alone correct faulty vision
American Optical



The projector is an ideal instrument for demonstration and lecture work outside of the office.

The Three Dimension TACHISTOSCOPE...

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The Tachistoscope projector, with a horizontal slide changer, is equipped with a Wollensak Alphax shutter.

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Polaroid light control filter designed for use with any standard slide either black-and-white or colored.

*TM Registered U. S. Pat. Off.

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AMERICAN JOURNAL OF OPTOMETRY
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AMERICAN ACADEMY OF OPTOMETRY

Vol. 22 AUGUST, 1945 No. 8

SPECIFICATION OF THE DIRECTION OF REGARD*

SPECIAL REPORT, NO. 1

AMERICAN ACADEMY OF OPTOMETRY COMMITTEE ON NOMENCLATURE AND STANDARDS

Glenn A. Fry, Chairman
C. L. Treleaven and R. C. Baxter

FOREWORD

Most of the work undertaken by this committee has been carried out since October, 1944, and it has not been possible for Lt. Baxter to participate. The Chairman and Professor Treleaven met in New York City October 21, 1944, and decided to submit to the American Academy a set of recommendations entitled "Specification of the Direction of Regard." The proposed recommendations were discussed in detail and it was decided that the Chairman should prepare a preliminary draft and submit it to the members of the committee for their approval or suggestions for revision. The preliminary draft was completed and submitted to the members of the committee on November 24. At the time of the preparation of this report the Chairman has not received replies from members of the committee. A reply cannot be expected from Lt. Baxter before the meeting in Chicago. It is likely that Prof. Treleaven will be able to transmit to the Chairman his suggestions and criticisms so that they may be incorporated into the report before its final submission to the American Academy in Chicago. In any event the report will be submitted to the Academy in Chicago.

In the report in 1939, the Committee on Nomenclature and Standards pointed out that one of the functions of the committee was to formulate a set of standards for quantitative specificaion of accommodation

* An abridgment of the material presented by the Committee, at the annual meeting of the American Academy of Optometry at Chicago, Illinois, December 11, 1944. For publication in the August, 1945 issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

and convergence phenomena. A tentative set of proposals was submitted at that time. The present set of proposals is a revision and amplification of part of the previous report and is being submitted for the Academy's approval.

It is the Chairman's opinion that when the Academy accepts such a report, the only interpretation that can be placed upon such action is that the Academy acknowledges that the proposals are worthy of consideration and use by members of the Academy and others interested.†

The special report on "Specification of the Direction of Regard" has been prepared as a basis for and in anticipation of subsequent reports on the measurement and specification of cyclophoria and torsion, and also on the specification of the placement of lenses before the eyes.

It is also recommended again as was done previously by the committee in 1939 that the American Academy consider the establishment of a fellowship to provide for the creation of an authentic history of concepts relating to accommodation and convergence and the formulation of philolgical definitions of terms which have been used for describing accommodation and convergence.

1. INTRODUCTION

It is the purpose of this report to call attention to certain points, lines and planes which are fixed with respect to the head which can be recommended for use for specifying the placement of the lenses before the eyes, and for specifying the adjustment of the head and eyes with respect to a visual training or testing device, and for the purpose of defining such anomalies as hyper-eye, differential protrusion of the two eyes, etc.

This report is an amplification and revision of part of the report (1) submitted in 1939.

2. DEFINITIONS

In order to establish a system of axes for specifying the direction of regard it is necessary to define certain planes, points and lines as follows. These definitions agree substantially with those advocated by Lancaster (2) insofar as they cover the same topics.

The Pupillary Axis. The pupillary axis passes through the center of the real pupil and is normal to the cornea (3).

The Entrance Pupil. The entrance pupil of the eye is the virtual image of the real pupil formed by refraction at the cornea (4). It represents what is actually seen when one person looks at another's pupil. It is, therefore, directly observable and can be experimentally located.

†Report accepted by Academy, December 11, 1944.

The center of the entrance pupil lies on the pupillary axis because the pupillary axis passes through the center of the real pupil and the center of curvature of the cornea.

There are two limitations to using the center of the entrance pupil as a point of reference. On the one hand the pupil does not necessarily contract concentrically and consequently the center may be displaced laterally and vertically as the pupil changes size.

Strictly speaking, therefore, one cannot assume that the center of the entrance pupil is fixed at a given point within the eye, but for most purposes it is satisfactory to assume that it occupies the same position as when accommodation is relaxed and the two eyes are converging on a distant target, or dissociated, and when the illumination is moderate.

On the other hand, the iris moves forward slightly during accommodation and consequently its distance behind the cornea is not a fixed quantity. In case it is not convenient or possible to measure the distance from the cornea to the entrance pupil, this distance can be assumed to be 3 mm. For most purposes this is a satisfactory approximation.

The Point of Fixation. When a person has one eye occluded (5) and is instructed to look with his other eye directly at a given point and makes an effort to do so, the eye is brought into a definite position with relation to the point. This phenomenon depends upon the fact that the eye turns so that the image of the point looked at is projected on some minute part of the retina, which usually lies within the fovea, and which remains constant in repeated attempts at fixation. The point looked at is called the point of fixation.

The Line of Sight. The line connecting the point of fixation and the center of the entrance pupil is known as the primary line of sight. (6). The significance of this name consists in this, that if a person tries to line up his eye with two points, one of which serves as the point of fixation, what he does is to get the two points in line with the center of the entrance pupil. If the eye is in focus for the point of fixation, the blur circle produced by the other point is concentric with respect to the image of the point of fixation.

In the case of a pupil with an irregular shape, the geometrical center of the entrance pupil may not be the most satisfactory point for defining the primary line of sight, and in such exceptional cases, it is to be understood that a different approach to the problem must be used.

So long as the pupil is radially symmetrical, decentration does not destroy the usefulness of the above definition of the primary line of sight.

In order to be consistent with the above definition of primary line

of sight, in a case of false fixation, one would have to define the primary line of sight as the one based on the eccentric fixation point. It is probably more helpful, however, in such a case to redefine primary line of sight as the line representing the incident path of the chief ray penetrating the center of the fovea. This at least corresponds closer from the anatomical point of view to the primary line of sight in a normal eye.

The Center of Rotation. It is possible to determine experimentally the point within the orbit, through which it can be assumed that the line of sight must pass regardless of the direction in which it is oriented. This point can be designated as the center of rotation (7). It lies on the line of sight about 13 mm. behind the cornea when the eye is in its straight forward position. It is fixed with respect to the head.

This concept of center of rotation has been used in the design of corrected curve lenses. Inadvertently, perhaps, it is also used in defining the length of the base line for computing the angle of convergence, because in assuming the length of the base line to be equal to the distance P.D., one also assumes the centers of rotation to be located on the lines of sight. Also in using the P.D. as a basis for the interocular adjustment of haploscopic devices, one attempts to make the axis of rotation of each arm of the instrument pass through a point that lies on the straight forward position of the line of sight.

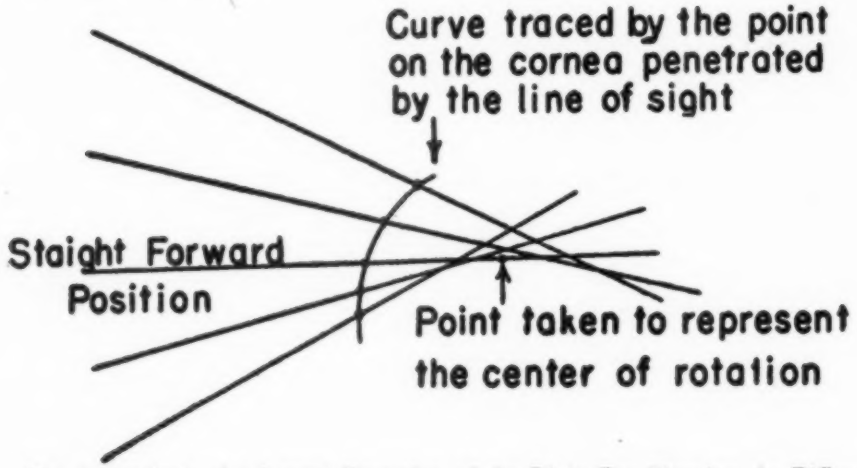

Fig. 1. Analysis of a Lateral Excursion of the Right Eye Showing the Different Positions of the Line of Sight.

Because of these practical applications, the above concept of the center of rotation will be used in the discussion that follows but it may be well to point out now some of its limitations.

Different directions of the line of sight do not intersect exactly at a common point, but form a caustic as shown in Fig. 1. The concept of the center of rotation as a point of intersection is, therefore, only partially justified.

When the eye turns in a given direction the curve traced by the point on the cornea that is penetrated by the line of sight is not a circle. This proves that the eye does not rotate around a point which is both fixed in the eye and also fixed in the orbit.

Rotations of the eye are accompanied by screw movements, so called, because when a screw turns on its axis it is translated in the direction of the axis. These screw movements can be demonstrated by getting the eye lined up with two parallel lines such as a pair of plumb lines at different distances and moving the eye along the length of one of the lines. A screw movement is demonstrated when the lines are seen in parallactic displacement.

As illustrated in Fig. 1, the distance from the cornea to the center of rotation is not constant for all directions of regard. Therefore, in specifying the position of the center of rotation it is necessary to pick out one position, namely the straight forward position, and then state that the center of rotation under this condition is so many mm. behind the cornea.

The movements of the eye can be analyzed in terms of rotation around a point at the center of curvature of the posterior surface of the eye, provided proper allowance is made for translation of this hypothetical center of rotation in various directions. This type of analysis could be used in accounting for eye movements in terms of contraction and relaxation of the several muscles.

Base Line. The line connecting the two centers of rotation may be called the base line (8).

Plane of Regard. Plane of regard (or plane of fixation) of either eye may be defined as the plane containing the base line and the line of sight. Since the lines of sight of the two eyes are usually directed toward a common point, it is seldom necessary to make a distinction between the planes of regard of the two eyes (9, 10).

Face Plane. The face plane is defined as one which is tangent to the chin and to the two superciliary ridges.

Primary Position of the Plane of Regard. Since the plane of regard is capable of rotating around the base line as an axis it is necessary to define the primary position as perpendicular to the face plane.

The Straight Forward Position of the Line of Sight. The line of

sight is in its straight forward position when the plane of regard is perpendicular to the face plane and the line of sight is perpendicular to the base line. This must be differentiated from the primary position which is defined as the position from which the eye can move to the right or left or up or down without inducing torsion (11).

The straight forward position is not necessarily parallel to the median sagittal plane of the head as defined below.

The Median Sagittal Plane of the Head. This is defined as passing through the occipital protuberance, the glabella, and between the two upper middle incisors. This plane also passes through the nasal spine of the superior maxillary bone and through the depression immediately beneath the nose. It divides the head into two symmetrical halves (12, 13).

Erect Position of the Head. The erect position of the head may be specified as one in which the median sagittal plane of the head and the face plane are both vertical (14).

Hyper-Eye. (15). This is the condition in which one center of rotation is higher than the other when the head is held erect. In this condition, the plane of regard is not perpendicular to the median sagittal plane of the head.

Differential Protrusion of the Two Eyes (16). This is the condition in which the two centers of rotation are not equi-distant from the face plane. In providing a measure of protrusion the Hertel type of exophthalmometer makes use of a base line connecting the two outer margins of the orbits, which is substantially parallel to the face plane. Protrusion can also be measured from the occipital protuberance as a common reference point for the two eyes, but measurements made in this manner do not correspond to those obtained by the first method when the face plane is oblique to the median sagittal plane of the head or when the eyes are not equidistant from the median sagittal plane.

3. SPECIFICATION OF THE DIRECTION OF REGARD

The direction of regard can be specified in several ways.

One scheme (17) employs angles of elevation (λ) and azimuth (μ). According to this system the plane of regard undergoes an elevation or depression, and the line of sight also rotates around an axis perpendicular to the plane of regard through an angle of azimuth. Zero azimuth is the azimuthal position perpendicular to the base line. This is the simplest of the three schemes to be described for the purpose of designating convergence, because convergence is a simple function of the

angles of azimuth of the two eyes. This is true regardless of whether the plane of regard is elevated or depressed or in its primary (zero) position.

Testing and training devices like the Eikomometer and the Orthorater induce changes in direction of the lines of sight which are analyzed mechanically in terms of azimuth and elevaton.

Another scheme (18) for specifying direction of regard makes use of angles of latitude (θ) and longitude (ϕ). In this scheme we have to suppose that the line of sight rotates around an axis (the secondary axis) which is perpendicular to the line of sight and which always lies in the primary plane of regard and rotates around an axis (the primary axis) which is perpendicular to the primary plane of regard at the center of rotation.

Longitude represents the rotation of the secondary axis around the primary axis from its zero position which coincides with the base line. Latitude represents the rotation of the line of sight upward or downward around the secondary axis, zero latitude corresponding to the primary plane of regard.

Testing and training devices like the tropometer, the synoptoscope, etc., induce changes in the direction of the lines of sight which are mechanically analyzed in terms of angles of latitude and longitude.

In adjusting a patient to any of these instruments, one should aim at placing the center of rotation of each eye as near as possible to the intersection of the vertical and horizontal axes of the target arm. Furthermore the face plane should be vertical.

A third scheme for specifying direction of regard is illustrated by the use of a perimeter for measuring the limits of the field of fixation. In this type of measurement the head is adjusted so that the center of rotation falls at the center of the arc and so that the straight forward position of the line of sight coincides with the axis of rotation of the arc and so that the plane of regard is horizontal.

The arc is set at a given position and the target is moved along the arc toward the periphery of the field. It is recommended that the meridional position of the arc be specified by using the same notation as that employed for cylinder axes, i.e., in facing the target as the patient does, the zero half-meridian is horizontal and to the left and the degree notations (κ) of the half-meridians increase in the clockwise direction from zero to 360°.

Angular distance (π) along the arc from its axis of rotation is called eccentricity.

Meridian and eccentricity specifications for the direction of regard are based on the assumption that the line of sight is perpendicular to and rotates around a secondary axis which is perpendicular to and rotates around a primary axis which is fixed with respect to the head and corresponds to the straight forward position of the line of sight.

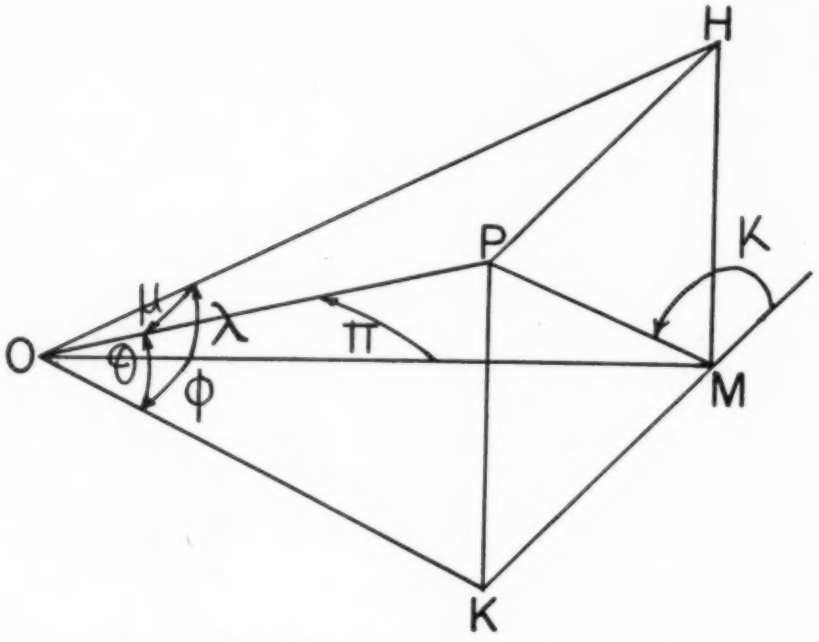

Fig. 2. Relationships Between o π, κ, θ, ϕ, μ, and λ.

The relations between π, κ, θ, ϕ, μ and λ for a given direction of regard are shown in Fig. 2. O represents the center of rotation and P the point of fixation. The triangle OMK lies in the primary plane of regard and OM represents the straight forward position of the line of sight. The rectangle PHKM is perpendicular to OM.

When the direction of regard is expressed in terms of θ and ϕ or in

$$\tan \lambda = \frac{\tan \theta}{\cos \phi} = \sin \kappa \tan \pi$$

$$\sin \mu = \sin \phi \cos \theta = \sin \pi \cos \kappa$$

terms of π and κ the specifications can be converted to terms μ and λ by means of the following equations which are based on Fig. 2.

Similar equations can be written for the reverse translations and for converting from terms of π and κ to terms of θ and ϕ and vice versa.

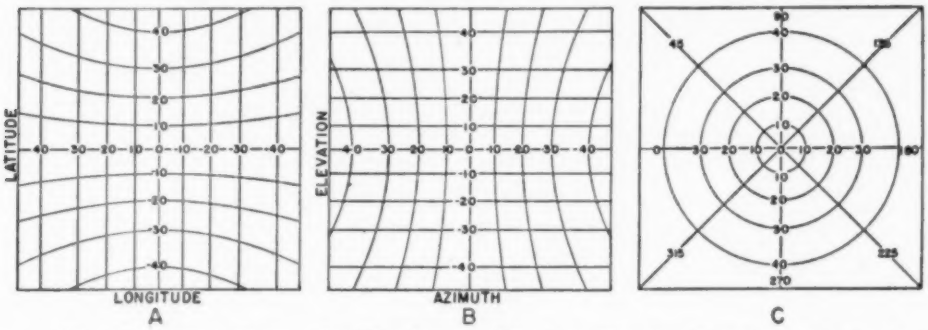

Fig. 3. Tangent Screens for Plotting the Direction Fixation Based on (a) Angles of Latitude and Longitude. (b) Angles of Elevation Azimuth. (c) Angles of Eccentricity and Meridional Direction.

Perhaps the most satisfactory way to demonstrate the differences between the three systems of specification is to present three tangent screens on which are plotted various values of θ and ϕ (Fig. 3A), μ and λ (Fig. 3B), π and κ (Fig. 3C). In each case the center of rotation must be assumed to lie on the line perpendicular to the center of the screen at a distance equal to one half the diameter of the screen.

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2. Walter B. Lancaster. Terminology in Ocular Motility and Allied Subjects. Am. Jour. of Ophthalmology. 26. 122-132 (1943).

3. L. Laurance. Visual Optics and Sight Testing. 29 (1926).

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5. Attention should be called to the fact that this definition applies fundamentally to monocular fixation. It is generally assumed in persons maintaining binocular vision. that the eyes assume the same position in fixating an object binocularly, as each would assume separately in monocular fixation. However, it is known [A. Ames, Jr., K. N. Ogle, and G. H. Gliddon. Corresponding Retinal Points, the Horopter and Size and Shape of Ocular Images. J. Op. Soc. Am., 22. 586 (1932)] that the points on the retinas used for fixation in binocular vision are not necessarily corresponding points. This disparity has been referred to as "retinal slip" and "fixation disparity." It seems that so far no one has taken the trouble to investigate carefully whether monocular and binocular fixation involve the same points on each retina.

6. M. Tscherning. Op. Cit., 89.

7. According to von Kries [Footnote in H. von Helmholtz. Physiological Optics (American Edition), 3. 128 (1925)] it is satisfactory as a first approximation to assume that the different directions of the primary line of sight intersect at a common point. R. S. Park and G. E. Park [Am. J. of Physiol., 104. 545-552 (1933)] also found this to be true and G. E. Park [Am. J. Ophth., 19. 967-974 (1936)] referred to the point of intersection as the "visual center." One difficulty with this name is that

it is already used to designate nerve centers in the mid brain and cerebral cortex that have to do with vision. Furthermore Park's choice of the name, "visual center," is based on the fact that the name "visual axis," was used to designate the line whose various positions intersect at the visual center. Park also referred to this line as the *visierlinie* which was used by Helmholtz to designate line of sight, and as a matter of fact the line which was used in the experimental procedure of Park and Park actually corresponds to the primary line of sight as defined above. It would, therefore, be consistent with Park's basic idea to call the point of intersection the "sighting center." The use of such a name as a substitute for center of rotation is certainly worthy of consideration.

8. H. von Helmholtz, Physiological Optics (American edition), 3, 42 (1924).

9. H. von Helmholtz, *Ibid.*

10. E. Hering, Spatial Sense and Movement of the Eye (Translated by C. A. Radde), 86 (1942).

11. Montagu [Physical Anthropology: Methods, a section in Medical Physics edited by Otto Glasser, 1033 (1944)] states that the Frankfort horizontal which is the plane containing the lowest points on the infraorbital margins and the tragion, or tragital notch of the ear corresponds almost exactly to the plane of visual axis, which obtains when the individual is looking straight ahead. This represents an entirely different approach to the problem, but is no more arbitrary than using the face plane as a starting point for defining the primary plane of regard. The advantage of the face plane consists in its direct application to the use of chin and brow rests for controlling the position of the head.

12. H. von Helmholtz, Op. Cit., 40.

13. G. T. Stevens, The Motor Apparatus of the Eyes, 90-91 (1906).

14. Helmholtz [Physiological Optics (American Edition), 3, 41, (1924)] defined the erect position as one in which the median sagittal plane is vertical and the glabella is in a vertical plane with the front surface of the upper teeth. Stevens [The Motor Apparatus of the Eyes, 91, 208 (1906)] modified Helmholtz definition by regarding the head as erect when the line connecting the glabella and the depression just below the nose (depression below the nasal spine in the case of a skull) is vertical. Both of these definitions are in substantial agreement with the one given above.

Since the face plane has to be defined for other purposes, one might as well make use of it in defining the erect position of the head. When an exact placement of the head is necessary, one would have to resort to the definition given by Helmholtz or Stevens, and only Stevens definition would apply to a case in which the teeth are missing.

15. S. E. Duplissis, Further Thoughts on Hyper-Eye, Op. Jour. and Rev. of Optom., March 15, 1937.

16. Section on Exophthalmometry in the American Dictionary and Encyclopedia of Ophthalmology (Edited by C. A. Wood), 4849-4850 (1915).

17. H. von Helmholtz, Op. Cit., 42.

18. J. P. C. Southall, Introduction to Physiological Optics, 170-175 (1937).

THE ZONE OF CLEAR SINGLE BINOCULAR VISION*

H. W. Hofstetter
School of Optometry
Ohio State University

PART II

Results
Analysis of Results
Summary
References

RESULTS

The zones of clear single binocular vision were obtained in 111 subjects. Most of these subjects were tested only once. Several were retested at various intervals during the three year period of investigation while others were retested several times within periods of only a few days. The following table shows the number of subjects retested and the period of time elapsing between the first and last test for each subject.

Number of Subjects	*Number of tests on each subject.*	*Time elapsing between first and second test.*
77	1	
1	2	1 day
4	2	1 day - 1 week
4	2	1 wk. - 1 mo.
4	2	1 mo. - 1 yr.
2	2	1 yr. - 2 yrs.
1	3	2 hrs.
2	3	1 wk. - 1 mo.
5	3	1 mo. - 14 mo.
3	4	2 mo. - 14 mo.
4	5	1 mo. - 12 mo.
1	6	27 days
1	7	31 days
2	7	14 mo. - 17 mo.

A number of selected graphs are included in figures 7, 8, 9, and 10. The dates indicate when the tests were made.

*This is the second of two parts of a paper dealing with the clinical aspects of binocular vision, which was presented to, and published on behalf of the Distinguished Service Foundation of Optometry, for publication in the August, 1945, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY. For Part One, the reader is referred to the July, 1945, issue.

The arrows indicate the order in which the plotted points were obtained. Numbers next to the arrows indicate which series of points were obtained first and which second. All of the series marked with the number one (1) in a given graph were completed before any of the series marked with a number two (2) were started.

The following symbols are used to represent points on the graphs:

o—Point at which a blur was reported.

+—Point at which a diplopia was reported without a preceding blur.

•—Point at which either a blur or a diplopia was reported but the original record carried no notation as to which it was.

□—Point at which a diplopia was reported after blurring had occurred. The zone between the squares and the circles represents a zone of blurred binocular vision.

x—Phoria.

It is quite evident that the limits of clear single vision may in some regions depend upon the absolute limits of accommodation while in other regions the blur or diplopia may result from the relationships which exist between accommodation and convergence. The former limits manifest themselves at the lower and upper regions of the graph while the latter limits may occur at any level of accommodation within the absolute limits of accommodation. At least approximately it can be said that the absolute limits of accommodation can be represented by horizontal lines at the top and the bottom of the zone while the limits dependent upon the relationship between accommodation and convergence can be represented by a straight line, or perhaps a curve, extending obliquely along the lateral limits of the zone. Now, unless a large number of carefully obtained blur or break points are obtained in the regions at which one of these two types of limits replaces the other, it is out of order to interpolate by simply connecting the points of blur or break in these regions with line segments.

To avoid interpolative errors in these transition regions, all of the blur points which may possibly have been dependent upon the zero limit of accommodation are connected to each other to represent the lower limits, and those which may possibly have been dependent upon the limit of maximum accommodation are connected to each other to represent the upper limit of accommodation. No graphical connection is made between these points and those which cannot be attributed to the absolute limits of accommodation, except in those cases in which the

transition region was explored very carefully and leaves no doubt as to the nature of the transition.

The corrections that were worn during the haploscope tests are noted in the following descriptive data. The fact that these corrections were worn in the form of spectacles instead of being mounted on the rotating arms of the haploscope introduced certain errors dependent upon the use of eccentric parts of the lenses during convergence and divergence. No allowance has been made for these errors in the plotting of the graphs. The following notes obtained from the clinic records are intended to supplement the data included in the figures. Unless otherwise indicated the visual acuity with the best correction is 20/20 or better.

Subject: W. K. (Figure 7)
Refractive error O.D. plano
O.S. plano
6 M. phoria ortho.
No complaints.
No Rx. worn previous to or during time of haploscope test.

Subject: J. H. (Figure 7)
Refractive error O.D. $+.50 \text{—} .50 \times 180$
O.S. $+.50 \text{—} .50 \times 180$
6 M. phoria 15 exo.
Complaints: headaches from use of eyes. Previous glasses which approximated the above refractive error never gave any relief.
No. Rx. worn during haploscope tests.

5/5/41 - 6/5/41 The headaches became very severe while the subject attended school at another university. The university eye clinic recommended no glasses but suggested convergence exercises. According to the subject's report the exercises provided were very difficult and strenuous but definitely gave her relief from the headaches.

8/5/41 Headaches became worse and more frequent again. A series of tests were then made with temporary prism corrections. A total of 4△ B.I. were worn two days for all of her reading and studying with no manifestation of headache. During the next few days the glasses were left off until a headache appeared and then worn with the result that the headache disappeared in a few minutes. The subject also reported the disappearance of a beginning headache when she put on the prisms during a movie. Without the subject's knowledge, the prisms later were changed to 4 base-out. Almost at once the subject reported that the

glasses no longer seemed effective and expressed considerable disappointment in their use.

9/5/41 The following was prescribed:
O.D. +.50 —.50 × 180 combined with 2 base in.
O.S. +.50 —.50 × 180 combined with 2 base in.

This correction has been found very satisfactory for reading, studying, and movie-going and, although they are not worn most of the time, the subject is never without them for occasional use.

Subject: V. S. (Figure 7)
Refractive error and old Rx. O.D. —1.25 —.50 × 180
O.S. —1.25 —.75 × 180

6 M. phoria 8 exo.
No complaints, but manifested an occasional exotropia at near of which he was not aware.
Haploscope tests made through old Rx.

1/7/41 - 2/14/42 Subject was given a series of 20 convergence training periods on the haploscope. Each training period consisted of about 15 minutes of repeated attempts to maintain fusion while the haploscopic convergence stimulus was alternately increased to the point of blur or diplopia and decreased to recovery. During these exercises the stimulus to accommodation was maintained at +1.00 diopter.

3/1/41 6 M. phoria 2 exo. Subject reports no visual discomforts and shows no tendencies toward exotropia. Near point of convergence is about 1½" from the spectacle plane.

Subject: S. L. (Figure 8)
Refractive error O.D. —.25
O.S. —.25

Complaint: Eyes water when doing close work.
Alternating exotropia of about 15 centrads. No evidence of paralysis.
No Rx. worn previous to or during haploscope tests.

In the first haploscope test the targets would not fuse properly but only passed by each other during increases and decreases in stimulus to convergence. The test was then made by means of a dot in the lower field of one of the targets and a dot in the upper field of the other. The

subject could identify "fusion" by the vertical alignment of the dots. The subject then reported when the upper dot went out of alignment to the right and when it went out of alignment to the left as the change in stimulus to convergence was reversed for each report. The filled circles on the first graph indicate the reports of "out-of-alignment" while the short segment attached to each circle indicates the direction the stimulus had to take to permit fusion. Thus it is seen that there is much overlapping of the limits of relative convergence. In the second graph the tropia was measured objectively for different amounts of accommodation and plotted as X's. The measurement was made by replacing one of the targets in Fig. 6B with a telescopic sighting device and a small source of light to determine the direction that the non-fixating eye assumed for various amounts of stimulus to accommodation to the other eye.

3/10/42 - 6/1/42 Subject has been given a series of 20 convergence training exercises on the haploscope. Each training period consisted of 10 to 15 minutes of repeated attempts to maintain fusion while the haploscopic convergence stimulus was alternately increased to the point of blur or diplopia and decreased to the point of recovery. During these exercises the stimulation to accommodation was maintained constantly at +.50 diopters.

6/1/42 The subject shows no tendency toward squint.

Subject: K. H. (Figure 8)
Refractive error O.D. +1.50 —.25 × 90
O.S. + .75
6 M. phoria 2 exo.

No complaints, but subject manifested an exotropia at near of which he was not aware.

No Rx. was worn previous to or during the haploscope tests.

Subject: T. S. (Figure 8)
Refractive error O.D. —.50
O.S. —.75 —.25 × 180

6 M. phoria: rotary prism and vertical dissociating prism technique shows 4 exo. but cover test shows approximately 15 exo. No complaints, but subject manifested an occasional exotropia of about 15 centrads. No Rx. was worn previous to or during the haploscope test.

Subject: R. T. (Figure 8)
Refractive error and Rx. O.D. plano —.25 × 15
O.S. +.25 —.25 × 180
6 M. phoria 10 exo.
Complaint: sensitivity to light.

Subject: J. E. (Figure 8)
Refractive error O.D. +1.75 —1.25 × 180
O.S. +2.00 —1.25 × 170
6 M. phoria 4 exo.
Complaints: Has had frequent headaches for years which seem to be associated with eyestrain.
Haploscope tests made through old Rx.
O.D. +1.25 —1.25 ×5
O.S. +1.25 —1.12 × 175
2/6/41 Rx. changed to O.D. +1.75 —1.25 × 180
O.S. +2.00 —1.25 × 170
Subject was seen several weeks later and reported no relief from headaches.

Subject: W. B. (Figure 9)
Refractive error O.D. plano.
O.S. plano.
6 M. phoria 1 eso.
Old Rx. for reading only: O.D. +1.00
O.S. +1.00
No Rx. worn during haploscope tests.

This subject was the only subject that has been observed to show a variation in the slope of the graph. The change was originally noticed in comparing phoria tests made from time to time. To verify the change a second haploscope test was made. The etiology has not been determined. It is interesting to note that at the time the second graph was made the subject had much less difficulty in reading and did not find it necessary to wear the reading Rx. as much. That the condition represented by the first graph was one of long standing was indicated by the fact that he had need for the +1.00 reading add for several years and showed a high esophoria at near for several years. After the second graph was made there were no signs of return to the earlier condition in the occasional phoria tests made for some weeks after.

Subject: E. M. (Figure 9)
Refractive error and old Rx. O.D. +1.00 — .75 × 5'
O.S. +1.00 —1.00 × 5'
6 M. phoria 3 exo.
Complaint: Eye fatigue and diplopia after prolonged reading.
Haploscope tests made through old Rx.

10/29/40 - 11/14/40 Subject has been given a series of 7 daily convergence exercises on the haploscope. Each training period consisted of about 15 minutes of repeated attempts to maintain fusion while the haploscopic convergence stimulus was alternately increased to the point of blur or diplopia and decreased to the point of recovery. During these exercises the stimulus to accommodation was held constant at zero. Subject reported very definite relief after exercises were started.

12/16/40 Subject has carefully checked his visual comfort during past several weeks under severe conditions and reports an unquestionable improvement in ease of seeing and visual comfort. This report was interesting inasmuch as the subject was reluctant to make any kind of a report until he was certain that he had made careful observation.

Subject: G. A. F. (Figure 9)
Refractive error O.D. —.50 —.50 × 100
O.S. —.25 —.75 × 97
No Rx. worn previous to or during time of haploscope test.

Subject: I. S. (Figure 9)
Refractive error O.D. —.25 —.25 × 7
O.S. —.62 —.25 × 15
6 M. Phoria 1 exo.
No complaints except blurring at near.
No Rx. worn previous to or during haploscope test.
The solid vertical line at the right of the graph represents the abcissa value of the near point of convergence measued by a push-up technique.

Subject: H. F. (Figure 9)
Refractive error O.D. —.50
O.S. —.50

Complaint: One eye diverges when subject is tired. The divergence gives a diplopia. Subject has habit of holding one eye closed to prevent diplopia when reading, etc. The subject can voluntarily obtain normal

binocular vision or let one eye diverge without changing his accommodation.

4/15/41 - 4/26/41 Subject has been given a series of 5 daily convergence training periods on the haploscope. Each training period consisted of about 10 minutes of repeated attempts to maintain fusion while the haploscopic convergence stimulus was alternately increased to the point of blur or diplopia and decreased to the point of recovery. During these exercises the stimulus to accommodation was held constant at zero. The training records were peculiar in that they showed two degrees of responses to the increases in convergence stimulus. In a series of attempts to hold fusion the subject was sometimes able to overcome from 20 to 30 centrads of stimulus before a blur of diplopia occurred and at other times could not prevent a diplopia from occurring at a stimulus of about —12 centrads. Very few responses fell between these two regions. The first graph can be compared to the weak response while the second graph can be compared to the strong response.

Subject: B. M. (Figure 10)
Refractive error O.D. +.25 —.12 × 90
O.S. +.50 —.37 ×
6 M. phoria 4 to 10 eso.
Complaints: Eyes burn when studying, movies tire eyes.
No Rx. worn previous to or during time of haploscope test.
A temporary Rx. of 3△ base-in was found very uncomfortable.
A subsequent Rx. of 6△ base-out was very satisfactory.

Subject: H. M. (Figure 10)
Refractive error +2.50
+2.50
6 M. phoria 8 exo.
Complaint: vision blurred after reading a while.
No previous Rx.
Haploscope test taken through +2.50 O.U.
12/2/42 New Rx. O.D. +1.50
O.S. +1.50
12/9/40 Subject reports much relief from new Rx.
2/15/41 Second Rx. O.D. +2.50
O.S. +2.50
3/1/41 Subject has found second Rx. very satisfactory.
A pair of +.75 O.U. held in front of this Rx. does not reduce his acuity. 6 M. phoria 5 exo.

Subject: K. R. (Figure 10)
Refractive error +.75 —.25 × 180
+.75 —.25 × 180
6 M. phoria 2 exo.
Complaints: Head and eyes ache at temples after reading.

4/9/40 - 4/28/40 Subject was given a series of 4 convergence training periods on the haploscope. Each training period consisted of about 15 minutes of repeated attempts to maintain fusion while the haploscopic convergence stimulus was alternately increased to the point of blur or diplopia and decreased to recovery. During these exercises the stimulus to accommodation was maintained at +2.50 diopters.

5/10/40 Subject reported no recent eyestrain. When the subject was seen about a year later he reported having had no eyestrain or difficulties from reading.

I

ANALYSIS OF RESULTS

A prerequisite to an adequate analysis of the results is a consideration of the deficiencies in the experimental procedure that may influence the haploscopic determination of the zone of clear vision.

In those cases in which the image blurs before it doubles when the stimulus to convergence is increased the onset of blurredness is dependent upon an increase in accommodation. Similarly, when the stimulus to convergence is decreased the onset of blurredness is dependent upon a decrease in accommodation. Fig. 9 (VII) illustrates the changes in accommodation that occur in going from one limit of relative convergence to the other as measured by the dynamic method described in the chapter on apparatus and procedure.

Fry [6, 7] has made similar measurements by a static procedure which produced the same type of curve. His procedure consisted in measuring the amount of accommodation in play for various degrees of convergence while the stimulus to accommodation was held constant.

Morgan and Olmsted [17] later made similar measurements of the accommodation for given amounts of convergence stimulus for a large number of subjects. Their results duplicated Fry's in showing small changes of accommodation for changes of stimulus to convergence within a range of about 29 centrads and rapidly increasing changes outside of this range.

In Fig. 4 (VI) are shown a group of sigmoid curves to represent

the type of empirical curves obtained when the accommodation is measured for various amounts of convergence at fixed amounts of stimulus to accommodation. The curves can be considered to represent either the tracings shown in Fig. 9 (VII) or the data obtained by Fry. The slope at any point of a given curve represents the rate of change of accommodation. The six curves represent the accommodation in play for each of six degrees of the stimulus to accommodation namely, 0, 1, 2, 3, 4, and 5 diopters.

Although the curves have not been extended to their limits they can be considered to lie between two parallel lines which act as common tangents to the curves.

The continuous changes in accommodation that take place within the range of relative convergence are not ordinarily observed in a technique involving subjective blurring as a criterion because the eye has a depth of focus within which blurring cannot be detected. Consequently there must always be some apparent freedom of play between accommodation and convergence which depends upon the range through which accommodation can take place without any subjective evidence of a blur.

Fry [6] has observed that for his own eyes the first noticeable blur occurs with approximately one-half diopter of over or under-accommodation. If we accept this value for the schematic analysis in Fig. 4 (VI) the zone of clear single vision can be represented by the area surrounded by the dotted lines. The dotted lines are determined by the limits to which either the stimulus to accommodation or the stimulus to convergence can be altered without producing a blur or a diplopia. For example, the six solid circles on either side represent the points at which a blur or a diplopia would occur if the stimulus to convergence were increased or decreased while the stimulus to accommodation was held constant at each of the successive values of 0, 1, 2, 3, 4, and 5 diopters. In other words, at these points the actual accommodation would differ from the stimulus to accommodation by one-half diopter. The top and bottom limits of the zone, likewise represented in the dotted outline, indicate the points at which blurring would occur if the stimulus to accommodation were increased or decreased beyond the limits of actual accommodation.

The accommodation changes that occur at the limits of relative convergence assist in preventing a diplopia at that point. It is evident, however, that these changes begin to occur long before the actual need for the change arises. Since the subjective blurring occurs as soon as the difference between the actual accommodation and the stimulus to ac-

commodation is equal to one-half the depth of focus, the measured range of relative convergence must vary with a decrease or increase in depth of focus.

The effective depth of focus is of course decreased by the use of any fixation target which is designed to provide very critical criteria for the presence of blur. The use of a very small point of light has been used by Ames and Gliddon [1] for example and was found to give very critical determinations of the amount of accommodation in play. The use of the Scheiner principle for determining changes in accommodation also represents a means of reducing the effective depth of focus since this method will usually detect changes in accommodation before a blur is observed. In this connection it can be pointed out that the zones obtained by Hess [9] represent exactly what would be expected if the depth of focus were quite small. Hess used a Scheiner disc for detecting changes in accommodation. His data describe an almost perfect parallelogram, Fig. 4 (I), which resembles very closely the zone of clear single vision represented in Fig. 4 (VI).

The diagram in Fig. 4 (VII) illustrates what happens when the depth of focus is increased. It was arbitrarily assumed in constructing the diagram that the subject could over-or-under-accommodate one diopter without detecting a blur. There are reasons for believing that one diopter more nearly represents the experimental value to be assumed as an average in this investigation.

Inasmuch as most of the observers were inexperienced they often found it confusing to decide upon a reliable criterion of blurring or diplopia. If the subject were permitted to formulate his own criterion he was likely to report a blur or diplopia which did not represent the limit of clear single vision but which may have occurred, for example, as a result of a moment's lack of attention. To avoid these errors the subject was instructed not to report a blur or a diplopia until he was certain that he could not recover from it, or until there was no doubt in his mind as to whether or not the limit had been reached. This attitude on the part of the observer would produce the same experimental results as an increased depth of focus.

Secondly, the use of a fixation chart of letters instead of fine lines or small dots, for example, would tend to increase the effective depth of focus since the forms of the letters may be readily recognized under a considerable amount of blur.

Experimental evidence of the effectively increased depth of focus in the haploscope procedure lies in the fact that the far point of accommo-

dation recorded by the haploscope usually exceeded the far point determined in a routine refractive examination by about one-half diopter. Thus the lowest blur point in the graphs of the emmetropes and the fully corrected myopes and hyperopes is usually about a half-diopter below the zero line.

The far point was originally determined in the refractive examination by the maximum amount of plus lens or minimum amount of minus which permitted maximum acuity for a Snellen chart at 20 ft. Hence the far point obtained in the haploscope included an error of about one-half diopter in excess of the amount permitted by the depth of focus during the routine refractive examination.

The diagram in Fig. 4 (VII) shows certain characteristics which are common to a large number of the haploscopic graphs. (1) The dotted outline indicating the limit of negative relative convergence is seen to have a vertical segment at the lower portion which is represented mainly by diplopia points (+'s). (2) The median portion of the same dotted outline consists of a straight line segment whose slope is the same as the slope of the median segment at the limit of positive relative convergence. (3) The upper portion takes the form of a curve following the contour of the curves enclosed within the limits of the zone. (4) The extreme upper segment consists of a horizontal straight line following the ordinate representing the absolute near point of clear vision. (5) The upper extremity of the limit of positive relative convergence consists of a vertical segment, determined by diplopia points (+'s). (6) The median portion fulfills the description of the median portion on the opposite side. (7) The lower portion takes the form of a curve following the contour of the curves enclosed within the limits of the zone. (8) The extreme lower segment consists of a horizontal straight line following the ordinate representing the absolute far point of clear vision.

It is to be observed that all of these characteristics are present in Fig. 4 (VI), but that they are less pronounced for the smaller depth of focus.

The figure also includes a series of squares to show the theoretical limits of convergence and divergence that can be obtained by permitting the eyes to over or under-accommodate to avoid diplopia. The X's are included to represent the phoria line and to show that they form a line parallel to the median portions of the convergence and divergence limits.

A study of the graphs in Figs. 7, 8, 9, and 10, will show the features to be present in almost every case in which the zone was mapped

out in sufficient detail to include the region in which the feature is expected to occur. It is interesting to note that the outline obtained in Fig.

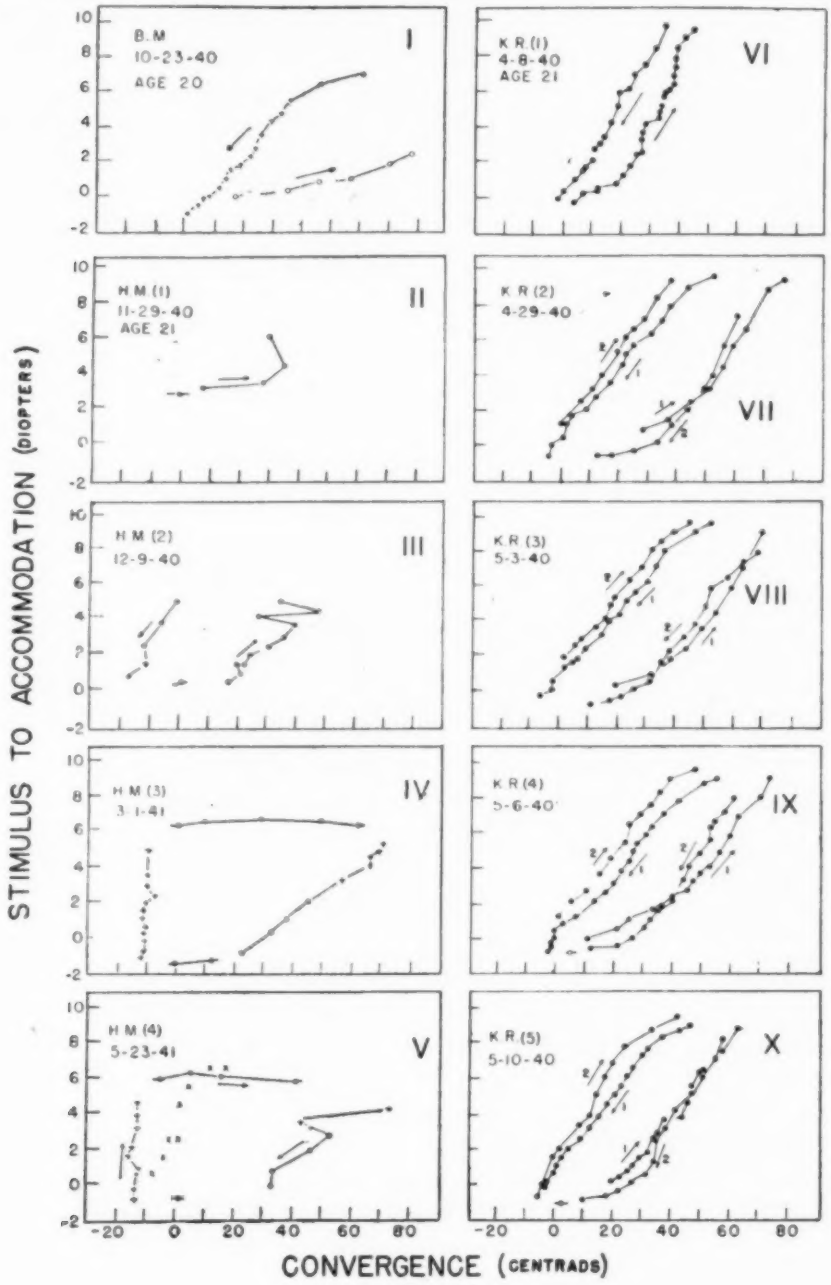

Fig. 10.

4 (VII) conforms very closely to the curves devised by Pereles [22] to represent the limits of relative accommodation and convergence.

If the haploscope zone for any given individual is analyzed in the reverse order it is possible to obtain a more adequate representation of the true relationship. Such a procedure is illustrated in Fig. II. In this figure the outer boundary circumscribes the zone as mapped out by the haploscope. If one-half the depth of focus is assumed to be one diopter, the error that the subject has made in going to the limit of the depth of focus can be corrected by subtracting one diopter from the stimulus to accommodation when the subject over-accommodated and by adding one diopter when he under-accommodated. These additions and subtractions are indicated by the arrows in the figure. The resultant inner zone then represents the zone of play between accommodation and convergence to be distinguished from the zone of clear single binocular vision included by the outer boundaries. It is of course not necessary to make this a part of the procedure in analyzing every record but the interpretation of each record is dependent upon the making of the proper allowances.

II

The next problem concerns the fundamental variations that are found in a large sample of records or graphs. A convenient classification can be made according to the variations in the geometric properties of the zone of clear single binocular vision as follows:

(a) The height of the zone. This represents the manifest amplitude of accommodation. (b) The width of the zone. This represents the range of relative convergence. (c) The slope of the zone. This represents the ratio of accommodative convergence to accommodation which for convenience has been called the ACA ratio. (d) The position of the zone on the coordinate system.

The height of the zone. Since the height of the zone represents the manifest amplitude of accommodation, variations in height can be produced both by the actual decrease in amplitude as occurs with age or by the inadequate control of accommodation as is evident in those who cannot obtain as high an amplitude in the haploscope as they can by more natural methods such as a push-up technique. Individuals of the latter type are likely to get a normal or maximum amplitude in the haploscope after a few trials or upon being advised to use their imagination to aid them to perceive the target as being very near. The graphical result obtained in those cases which show simply an inadequate control

of accommodation indicate that the width and the slope of the graph are not affected. Figure 7 (IV) illustrates the zone for one of three subjects who were unable to bring into play the maximum accommodation during the haploscope tests. Their subsequent records showed no change in slope or width, only a change in height, as may be seen in Fig. 7 (V-X).

A similar effect is produced when an individual finds it impossible to completely relax the accommodation in an artificial situation such as is provided by the haploscope. An example of this is illustrated in Fig. 10 (II) in which it is seen that the manifest far point of accommodation is about 2.50 diopters nearer than that obtained in the routine refractive examination. In this figure the negative relative convergence was not recorded. A comparison of the limit of positive relative convergence in this record with that of subsequent records for the same individual shows no significant changes even though the subject was able to relax the accommodation more in the second and third tests.

If a decrease in amplitude is dependent upon a decrease in the efficiency of the peripheral mechanism of accommodation such as, for example, a partial paralysis of the ciliary muscle, a change in slope would be expected, as pointed out by Flieringa and van der Hoeve [5]. The only subject who presented any such possibility was the one represented in Fig. 9 (I and II). A comparison of these two records shows a significant difference in the ACA ratio and a small difference in the amplitude of accommodation. The fact that the increase in ACA is large while the change in amplitude is small is in accord with the results of Flieringa and Hess. However, in the present investigation this was the only instance of a significant variation in the ACA ratio.

Another method of analyzing the effect of reduced amplitude on the shape of the zone is that of arranging the graphs according to age. This arrangement very closely parallels the arrangement in order of amplitude. A general inspection of the graphs of the 111 subjects so arranged did not reveal any trends in any of the features of the graphs except for the decrease in height or the decrease in amplitude of accommodation with age.

This type of information has considerable bearing upon the theories concerned specifically with the relation of the amplitude of accommodation to the effort required to accommodate. Donders [3] has, for example, stated that presbyopes can expect difficulty whenever the accommodation exerted for prolonged periods exceeds half of the amplitude. The assumption is that in those presbyopes the effort represents

more than half of the total ability, whereas the same amount of accommodation in a prepresbyope would represent a smaller fraction of his total ability. Flieringa and van der Hoeve [5] on the other hand proposed that the muscular exertion required to produce one diopter of accommodation remains practically the same at all ages. Hence the presbyope with an amplitude of 4 diopters, for example, would require no greater contraction of the ciliary muscle to produce 2 diopters of accommodation than a prepresbyope with an amplitude of 10.

If Donders' concept is true and if the ratio of innervation to accommodation and innervation to accommodative convergence is fixed, the ratio of accommodative convergence to accommodation would be expected to increase with age. The records in this study did not indicate any such changes.

The width of the zone. Some of the variations occurred as a result of training. This was demonstrated in various ways. In those cases in which a series of haploscope tests were made from time to time it was readily observed that the successive zones show regular increases in width. Also the individuals who were given convergence training between haploscope tests showed large increases in range that were directly attributable to the exercises. The changes in width that were brought about by such convergence exercises were equal at all levels of accommodation. Thus a subject who was given a series of daily convergence training exercises for a period of a week or two with the stimulus to accommodation constantly at zero showed as much increase in the width of the zone at the upper levels of accommodation as at the zero level. Under these conditions the median portions of the limits of positive and negative relative convergence always remained parallel.

Finally, the effects of repetition appear quite obvious in the records which include two series of haploscope findings taken in opposite orders. Fig. 10 (VII-IX) show a crossing over of the lines representing the findings taken in one direction and the lines representing the findings taken in the other direction. Such changes taking place during the test undoubtedly account for a large number of the variations in slope and the frequent failure of the two limits to show a reasonable degree of parallelism. This is further borne out by the fact that the anomalies in form that appear in the first test often disappear in subsequent tests. Cf. Figure 8 (VII-X).

In general the variations in range of relative convergence are greater at the positive limit than at the negative limit and it is this limit which lends itself more readily to training. Also, the variations in range gen-

erally are not followed by variations in position of the phoria. Although occasional variations in phorias do occur they apparently are not directly dependent upon variations in the width of the zone. This is evident from the fact that a number of the individuals who manifested definite

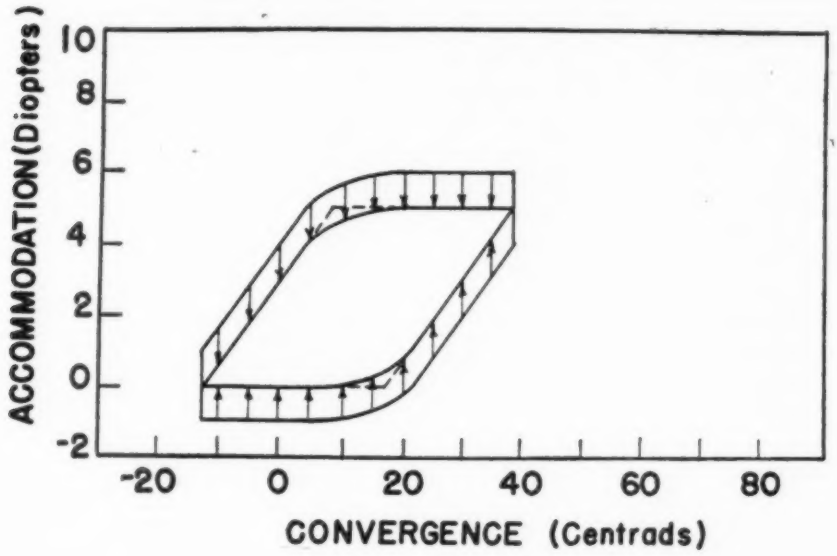

Fig. 11

increases in their range of relative convergence showed no significant changes in phoria.

A schematic representation of what takes place within the zone of clear single vision with variations in width of the zone is illustrated in Fig. 4 (VIII). The dotted curves illustrate how the solid curves are extended by training. The diagram shows that the variations in relative convergence are to be accounted for by changes at the positive side while the negative side and the phoria position remain constant. Furthermore, such changes occur without any change in the slope of the zone.

Changes in slope. With the exception of the case represented in Fig. 9 (I and II) there was no evidence of significant variations in the slopes of the graph in any of the subjects. One other case which may appear to show a true variation is represented in Fig. 8 (VIII and IX). The two records were obtained within the same hour, however, and so it is probable that the manifest slopes are the result of chance variations. Preceding and subsequent records of the same subject show no such anomalies.

A question which arises in connection with the slope of the curve concerns the effect of conditions of ametropia on the relationship between

accommodation and convergence. For this reason the cases were subdivided into 5 classes of ametropia.

The subjects were classified into 5 groups as follows:

1.	Under-corrected myopes	12 subjects
2.	Fully-corrected myopes	19 subjects
3.	Under-corrected hyperopes	9 subjects
4.	Fully-corrected hyperopes	7 subjects
5.	Emmetropes	64 subjects

The classification was made on the basis of the subject's average ametropia, i.e., the average refractive error for all meridians of the two eyes. For example, the average for the correction,

O.D. —.50 sph. — .50 cyl. × 180
O.S. —.75 sph. —1.00 cyl. × 180

would be —.75 for the right eye, —1.25 for the left, and —1.00 for the two eyes.

The under-corrected myopes included not only the subjects who manifested an average myopia of more than one-half diopter and had been wearing no glasses, but also those who manifested an average myopia more than one-half diopter greater than that corrected by the glasses which were being worn. The fully-corrected myopes represented the myopes of more than one-half diopter who were wearing glasses that were within one-half diopter of the full correction.

Similarly, the under-corrected hyperopes included not only the subjects with more than one-half diopter of hyperopia who were not wearing glasses, but also the subjects who manifested a hyperopia of more than one-half diopter greater than that corrected by the glasses being worn. The fully-corrected hyperopes included the hyperopes of more than one-half diopter who were wearing glasses that were within one-half diopter of the full correction.

The emmetropes included all those who showed an average ametropia of not more than one-half diopter.

A general inspection of the figures did not reveal any characteristics peculiar to any one group. It was not possible to recognize the myopes or the hyperopes by the shapes of the zone as Donders proposed. If there is any correlation of the ACA ratio with the degree of ametropia it was not apparent in the graphs obtained.

Changes in position. A few individuals manifested unusual changes

in the limits of relative convergence which are easier to describe in terms of a complete shift of the zone to the right or to the left. The best example of this is that illustrated in Fig. 9 (IX and X). The zone as measured on one day is completely outside of the zone measured on another. The subject in this case was an intermittent exotrope.

This phenomenon has been demonstrated only in squinters. A study of the data so far obtained has not permitted a thorough analysis of the problem. The immediate significance to be attached to this anomaly, however, is that it demonstrates the possibility of a complete shift of the zone of clear single vision.

III

The next general problem to be considered is the relationship of the zone of clear single binocular vision to the difficulties that arise in the use of the eyes for ordinary visual tasks.

Various authors have attempted to formulate general rules for determining whether or not an individual can be expected to have comfortable binocular vision on the basis of the range of clear single binocular vision. These rules can be classified into two fundamental types, depending on whether they take into account only the range of clear single binocular vision or whether they consider the range with respect to the phoria. The former have their best representation in the criterion proposed by Percival [20,21] while the latter are represented by Sheard's [26,27] criterion.

Percival's proposition was that if the point on the graph representing the amount of accommodation and convergence necessary for the clear single vision of the fixation object lay in the middle third of the range of relative convergence the patient could expect comfortable vision. He limited the application of this rule to the use of the eyes for seeing beyond 33 centimeters. If the above-mentioned point is referred to as the point of demand the rule can be stated briefly by saying that the point of demand must lie in the middle one-third of the zone.

Sheard took into account the phoria for any given distance of fixation and considered the graphical distance from the phoria to the point of demand as the visual load to be overcome, or, simply, the "demand." The ability to overcome the load or demand was represented by the graphical distance from the point of demand to the limit of relative convergence in the opposite direction, or, simply, the "reserve." Thus the "reserve" for an exophore would be represented by the distance from

the point of demand to the limit of positive relative convergence while the "reserve" for the esophore would be represented by the distance from the point of demand to the limit of negative relative convergence. Sheard's rule then stated that for comfortable binocular vision, the reserve must be at least twice the demand. It is probably a matter of coincidence that the application of either of the two rules usually leads to the same clinical result. That is, in most cases the requirements of both criteria are fulfilled by the same procedure or prescription. In only a few cases can the relative merits of the two criteria be tested.

A study of the visual complaints offered by the subjects reveals the fact that at best they are usually very general and often quite contrary to the complaints offered by another subject showing the same type of anomaly in the zone of clear vision. In general, however, the cases which fulfilled the requirements of both of the criteria reported no visual complaints other than those which could be attributed directly to the failure of a correction to provide clear vision for all working distances. A few of the cases were able to offer quite definite information by means of check tests which consisted of the temporary use of lens prescriptions which aggravated the condition indicated by the graphical analysis of the zone of clear vision. Cf. subject J. H., Fig. 7.

The visual difficulties of the subjects who failed to fulfill the requirements of both Sheard and Percival and who submitted themselves to various check tests were very definitely identified to arise from the conditions indicated by the zone. The check tests were made by means of temporary lens prescriptions which either aggravated or alleviated the condition and so gave evidence that the diagnosis was correct. Subject B. M. Fig. 10 (I) may be referred to as a good example of this type of case.

In two of the cases the opportunity to differentiate the relative merits of the two criteria presented itself. These are represented in Fig. 7 (II-III) and 9 (III-V). According to Sheard's criterion the subject in Fig. 9 (III-V) could expect to have visual difficulties at ordinary reading distances and the subject in Fig. 7 (II-III) could expect to have visual difficulties at both distance and near. This diagnosis would be based on the fact that the reserve was not equal to at least twice the demand. According to Percival's criterion, however, both subjects could be expected to have comfortable binocular vision. The complaints offered by the subjects conformed closely to Sheard's analysis. The results from the use of temporary lenses and the alleviation of the conditions by means of convergence training identified the diagnoses based on Sheard's rule as

correct. In these two cases the criterion offered by Percival did not aid in the diagnosis.

In addition to those who provide indications of anomalous zones of clear visions by the various complaints of ocular discomfort there are those who have avoided the subjective symptoms by suppressing the vision in one eye and permitting that eye to deviate to the phoria position. The subjects who show a deficiency of "reserve" for all distances of fixation are inclined to manifest either an intermittent squint or a constant squint. Examples of this are the subjects represented in Fig. 8 (I-III and V) and Fig. 9 (IX-X). Such individuals are not always aware of the squint and so have no specific complaints to offer that would lead one to suspect the squint.

The subjects who show a deficiency of "reserve" for only near or distant vision often show a periodic squint. In these cases a deviation of one eye occurs only when the object of fixation is at the distance for which the reserve is low. This situation occurs most frequently in the subjects who show a low ACA ratio, that is, the graph shows very little slope, making the subject approximately orthophoric for distance but extremely exophoric for near. Examples of this are the subjects represented in Fig. 8 (IV, VI).

As pointed out in the preceding paragraph these individuals are not always aware of the squint and consequently offer no specific complaints that would lead one to suspect the squint. This type of squint is more likely to remain undetected because it is not observed by the subject's friends or parents as readily as a squint which occurs with distant fixation. Even the refractionist may fail to detect the deviation unless he carefully observes the movements of the eye during a binocular push-up test for the subject usually does not report a diplopia by this test. For some reason or other these subjects often do not show a tendency to suppress the vision in one eye during the muscle-balance tests employed in a routine examination.

The tendency on the part of some individuals to suppress the vision in one eye and so permit the eye to deviate when the "reserve" is deficient may be interpreted in either of two ways. It may be suggested that the suppression was the precursor in the situation and that the "reserve" never had an opportunity to develop. The other interpretation is that the low "reserve" or the small range of relative convergence was the precursor and that the suppression was learned to avoid the discomforts that might arise from binocular vision. It is of course possible that some of the cases represent one order of events and some represent the other.

The significant fact that has been demonstrated by two such cases one of which is graphed in Fig. 8 (I-III) is that some of these squint cases respond favorably to training and are eventually able to avoid squinting at all distances. With this ability to avoid squinting there was manifested in both cases an increased range of relative convergence.

SUMMARY

The typical zone of clear single binocular vision as mapped out by the haploscope has the form of a parallelogram with certain characteristic deviations from that form which for the most part depend upon the presence of a finite depth of focus. The extent to which the shape of the normal zone deviates from the shape of a parallelogram varies directly with the increase or decrease in the depth of focus. These deviations in form for a large depth of focus are such as to make it difficult to relate the shape to that of a parallelogram. Hence, the empirical zones have given rise to a variety of interpretations and concepts which account for much of the confusion as to the fundamental relationship between accommodation and convergence. If the zones of clear single binocular vision as mapped out with the haploscope are analyzed in terms of what would result if allowance were made for the depth of focus they can be used for clinical and statistical studies of variations that occur in the fundamental relationship between accommodation and convergence. Such variations have been studied in a large number of cases and the data have been analyzed in terms of the fundamental variations in the zone of clear single binocular vision which include its height, width, slope, and position on a coordinate system.

It has been found in this analysis that:

(1) There is no characteristic variation from the normal relationship associated with cases of uncorrected ametropia. (2) It has not been found possible to change the slope of the zone by training. (3) There is no change in the slope of the zone associated with various age levels manifesting different amplitudes of accommodation. (4) There is no change in the slope of the zone associated with reductions in amplitude of accommodation dependent upon the inability of a subject to completely relax accommodation or to exert accommodation to its full extent. (5) The width of the zone can be increased by training. Such an increase in width at one level of accommodation is effective in bringing about equal increases at all levels. (6) Changes in the width of the zone have no effect on the phoria position. (7) Variations in the negative side of the zone are negligible in comparison to variations in the positive side.

These findings carry important implications for the theory of the neuromuscular mechanism subserving accommodation and convergence. The most important point at issue is whether or not it is possible to change the slope of a zone by training, or whether, for a given individual, there is always a fixed ratio between accommodation and the so-called accommodative convergence. It is easy to see how, by partial paralysis of the ciliary muscle one could affect the slope of the zone as has been done by Flieringa and van der Hoeve [5] because the effect on accommodation resulting from this type of paralysis could not have any influence on the muscles activated by the innervation to accommodative convergence.

In order to account for the fact that there does not occur any change in the slope of the zone as the amplitude decreases with age it must be assumed that, in spite of a reduction in amplitude, the same amount of innervation is required at all ages for any submaximal amount of accommodation. In this event the effect of age is merely to limit the extent to which the crystalline lens can be made to change its curvature. This, however, is in conflict with Donders' observation that untoward symptoms are apt to arise when a beginning presbyope uses more than one-half of his amplitude of accommodation. If no more effort is required by a beginning presbyope to make his crystalline lens accommodate for a reading distance than is required of a prepresbyope with, say 10 diopters of accommodation, the reasons for the existence of such symptoms in the presbyope are not apparent.

The clinical value of the measurements of the relationship between accommodation and convergence has been considered with special reference to Sheard's and Percival's criteria of discomfort arising from lateral muscle imbalances. In general those individuals whose findings satisfied both criteria reported no visual discomfort attributable to muscle imbalances. In the two instances in which the two criteria did not show agreement the final diagnosis favored Sheard's. Further, there are indications that the criteria are applicable not only in the analysis of ocular discomfort but also as indications of tendencies to squint without necessarily eliciting ocular discomfort.

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ADJUSTMENTS OF RETURNED SOLDIERS*

Clarence R. Carpenter, Ph.D.
Pennsylvania State College †

Optometrists are surely interested in the adjustments of soldiers who have returned to civilian life. This is true because of personal relationships with service men, because of professional relationships or because of concern about the general social welfare. Eleven or twelve millions of men did not leave their homes and civilian work for the military services and the work of war without important effects both to themselves and to their fellow citizens. Eleven or twelve millions of men will be returned from the armed forces to their civilian roles: the impact of their changed statuses will be great for the general body politic and for every public function or profession including optometry.

It is the purpose of this paper to call attention to a range of contingent viewpoints, problems and actions; viewpoints which may be helpful in your thinking about the processes of socially and professionally absorbing enormous numbers of ex-soldiers; problems which alike concern the ex-service men and civilian colleagues; actions which are most likely to yield satisfactory results.

The dean of one of our largest medical colleges said recently, "I have interviewed several dozen doctors who have returned from the military services. These men fall nearly into four or five groups. Each group has a set of common problems. It is our intention to plan re-training programs for groups which we can define."

The dean was looking at the problem from the practical point of view of his institution. The returnees *may* fall into "neat groups" when their professional training alone is considered. However, the dean will learn sooner or later that when the whole readjustment experiences of returnees are considered, this will show tremendous variation from individual to individual. It is probably a sound psychological opinion that neither can this dean nor any one else responsible for helping ex-servicemen readjust, work out a set of simple rules which will apply fittingly to large numbers and kinds of men. The reactions of individuals

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† State College, Pennsylvania.

* An abridgment of one of the current papers of the Optometric Extension Program, submitted for publication by the Public Health Bureau of the American Optometric Association, in the August, 1945 issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

to military service vary greatly; their readjustment problems and processes will differ accordingly.

VIEWPOINTS

1. The majority of returning service men will not be battle casualties; wounded, maladjusted, psychotic or lawless. (These are eliminated for the purposes of this paper.) There is a widespread stereotype of thought to the effect that ex-soldiers are invariably sick or morally degenerate. A consequence of this kind of thinking lends emphasis to all kinds of *rehabilitation* schemes and programs. These propositions should be critically analyzed and validated before conclusions are reached.

In the first place, only a relatively small percentage of our vast military personnel have seen battle action and these have seen action for only relatively short periods of time. Most battle wounds and injuries are rather minor and the subjects quickly recover. In the second place, it should not be hastily concluded that military service has had an undesirable or detrimental effect on individuals.

On the contrary, military training has benefited millions of men by training them to assume responsibility, by improving them physically, by teaching them to live and work with other men in the interest of a common objective, and by giving them experience in adjusting to a wide range of situations. It should not be overlooked that many ex-soldiers have acquired skills which can be applied directly to civilian life. Furthermore, millions of service men have had opportunities to expand greatly their knowledge of peoples and of the world in which they live.

2. The rates and qualities of social changes are speeded up during a world war. Adjustment demands have increased alike for the soldier and non-soldier. The problems of postwar readjustments will confront in equal measure the men who have worked at home and the soldiers who have worked more directly at the business of making war. Therefore, whom shall we *rehabilitate?* The answer is that all of us must readjust to changed political and economic conditions. And, note this: we must adjust not to those conditions which prevailed before the war, not to those conditions which we may now observe, but to a changed world. The precise nature of this changed postwar world cannot be defined but can be only vaguely imagined.

Shall soldiers readjust to the socio-economic order back home? Some may wish to do so. Many will say, "I don't fully approve of the conditions at home as I know them. I expect to change a few things, things which have come to be very important to me during my period of service."

The prospects are that returned soldiers will not adjust passively to what they will find back home. Their personal impacts on the whole country will be great, the results far reaching and largely unpredictable.

3. Soldiers and civilians do not make up two distinct groups. Most soldiers are "civilians in uniform." Few have closely identified themselves with the armed services. The veneer of soldiers and sailor habits will be, to a great degree, cast off with the uniform and older and more firmly established prewar habits of living and working will be reactivated. However, for those men who have learned to like the armed services or who have found the services more satisfactory than anything they had previously known, (there are more than a few of these) they may not wish or need to return to civilian life.

Millions of civilians have met problems equally as demanding as those met by soldiers during this war period.

The point is that both ex-service men and civilians have many common adjustments to make. Common problems and interests should be emphasized in the interest of everyone and to the end of preventing the development of a self conscious, self interested pressure group of ex-service men.

It would perhaps be wise for organizations and government agencies to broaden the base of "*re*habilitation programs" to include all of us, soldiers and civilians, the whole people.

4. It is probably generally true that to consider a returned service man as an object of mercy will embarrass him. He has probably matured a great deal; he is not the same person who went to war, if he left when he was young and has spent several years in active service. He will not want gifts but he will want opportunities. He will not want his problems solved for him but he may need guidance in their solution. He will not respond favorably to a condescending attitude; he will want to be met as man to man.

PROBLEMS

A good estimate can be made of problems which discharged ex-service men will meet by comparing the characteristics of living and operating situations in the armed forces with the living and working situations under civilian conditions. Those factors which are highly similar or identical in the two complexes of situations will create no problems and need not be mentioned. On the other hand those characteristics which are different will, in the *degree to which they differ*, create

demands or needs for adjustment. These factors are briefly described in the following chart:

CONTRASTS BETWEEN MILITARY SERVICES AND CIVILIAN LIFE

Factors or Characteristics	MILITARY SERVICES	CIVILIAN LIFE
Economic Resources	Dependable and regular. Requires little thought on part of individual. Large degree of uniformity within class or rank. With few exceptions in field grade officers and above, living standards generally very low.	Undependable and irregular, requires much of effort of individual. Great variability within and among classes. Income generally higher than in the services.
Expenditures	Sporadic and usually for non-essentials. Spending on the average likely to be wasteful. Value of money likely to be disregarded and money is spent for immediate satisfactions.	More influence from factors which encourage wise spending and thrift. Need for saving and planning more obvious. Effort to earn money related to spending.
Social Relations	Intimate and largely uni-sexual except sporadically. Little or no privacy. Social contacts numerous and close relations generally few.	More remote and heterosexual. Privacy in relatively large degrees or a matter of choice. Social contacts with fewer people and tend to be of stronger quality.
Social Status	Largely fixed by rank or rating. Status constantly emphasized. Change in status slow but quickly and clearly recognized. Fixed attitudes and prescribed behavior toward superiors and subordinates.	Fluid and relates to economic status, family, profession as well as a number of indefinite factors. Change in status variable but usually very slow and not quickly or clearly recognized. Attitudes and behavior toward others supposed to be "democratic."

Responsibility

Clearly defined and limited. Authority delegated from above. Except to a small degree and with high ranking officers. Individual initiative beyond defined duties discouraged.	Vaguely defined. Largely self assumed. Individual initiative emphasized. Authority vague and often assumed.

Purposefulness

Specific objectives continuously defined and checked. "Missions" prescribed and operations planned. Interdependence of personnel and cooperation obviously important.	Objectives ill-defined. Statement of purposes largely dependent on individual. Few external checks on accomplishments. Planning haphazard and circumstantial. Reduced emphasis on interdependence and cooperation. Emphasis on "individualism" and competition.

Recreation

Generally prescribed and organized. Supplied entertainment of limited variety. Opportunities for "binges" without direct social pressures of intimate acquaintances, relatives and close friends. Physical training.	Depends on interests and resources of individual. Behavior subject to public opinion pressures. Erratic and non-systematic physical training.

Personal Security

Great variation but ranging to point where soldiers at front or in battle do not expect to live. Risks are orders of the day.	Cooperative safety. Even normal needs for adventure usually not satisfied.

Many other comparisons and contrasts could be made but these are of basic importance and serve as examples. Where there is great disparity between factors in the two spheres of activity, there will be corresponding adjustment difficulties.

It would be valuable and practical to make out a comparison chart for an individual soldier. This is especially desirable because conditions vary from service to service and from one civilian life situation to another. Generally this procedure may be useful, for it tends to check the use of emotionally charged thinking, stereotypes and generalized abstractions.

What problems are likely to arise from the active optometrists? The average soldier, sailor and airman has been well taken care of by the "medics." This care has been given without regard to cost and it has cost the service man nothing. He has been quickly and usually satisfactorily fitted with glasses. Generally this has been done by an enlisted man under medical supervision. To this there may be exceptions. This type of care and other medical aids has made the service man dependent. He has come to take these advantages for granted. He may expect liberal considerations for all health aids when he returns to civilian life. He may resent relatively usual charges. However, he will appreciate being considered as a person and not as a "body" or just another soldier.

RECOMMENDED ACTIONS

1. Treat ex-service men exactly as you would a civilian, avoid special privileges, condescensions and attentions.

2. In case individual ex-service men have special problems and need help, avoid emotionalism and make objective analyses of the involved factors.

3. Anticipate that men you have known prior to the war will have matured and otherwise personally changed. Arrange opportunities for getting reacquainted with them.

4. Plan in advance procedures and explanations for the ex-service men who carry over into civilian life attitudes of dependence and acceptance of free health and medical services.

5. It may be worth while to remind all ex-service men soon after they return and at intervals thereafter that they may need visual examinations. Send reminder cards to your former patients.

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Minneapolis 2, Minnesota

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PILOT COMMENTS ON OPTOMETRIC WORK IN ARMY HOSPITAL

In the Paris Edition of THE STARS AND STRIPES[1], the Daily Newspaper of the U. S. Armed Forces in the European Theater of Operations, we find the following letter to the Editor which again reviews the real contribution made by optometrists in the Armed Services, to the health needs of our troops.

> I am again a regular pilot and want to take advantage of this column to thank a "T/4 doctor" whose work is responsible for my present flying status. About a year ago I was injured in a forced crash landing. At the

hospital the doctor told me that one of my eyes was injured and consequently, because of reduced vision, I would be grounded.

I didn't give up the idea of flying and not long ago went to a general hospital and had some T/4 examine my eyes. And after he was done I was able to see perfectly again with a pair of glasses.

Being grateful I naturally inquired about this T/4 and found out he was an optometrist. This optometrist did more for me than anyone else in the hospital. I thought this should be brought to the attention of the readers and proper authorities. There's something wrong somewhere, this doctor deserves much more than a T/4. I know, I was his patient and can fly again.—*Lt. A. S., 9 AAF.*

In the final analysis the results of our professional work are paramount. Proper recognition of our skills will follow, providing we aggressively press our claims, based in full, upon these results.

CAREL C. KOCH

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[1] Stars and Stripes. Paris Edition. Published at the New York Herald Tribune Plant, 21 Rue de Berri, Paris. Vol. 1, No. 323. Friday, June 15, 1945. Page 2.

WAGNER-MURRAY-DINGELL BILL AMENDMENT INCLUDES OPTOMETRY

The Wagner-Murray-Dingell Bill which has been re-introduced in the Senate differs in a number of respects from the original bill. The revised bill is some 95 pages longer than the original, and adds a new title to the Social Security Act for loans and grants to hospitals and other health center construction programs. It also makes possible appropriations and services to establish a more effective program for the prevention, treatment and control of venereal diseases and tuberculosis and to expand the public health program. It provides grants to the states for maternal, child health, crippled children and child welfare programs and for assistance to the indigent which will include medical care. Section 9 will amend title II of the Social Security Act to make possible a national social insurance system providing for prepaid personal health services and unemployment and temporary disability benefits, retirement, survivor and increased disability benefits, and a national social insurance trust fund. Amendments will bring an estimated 15 million additional persons under the provisions of the act. These services will be financed by a 4% contribution of the employer and an additional 4% contribution by the employee. In the words of Senator Wagner, the benefits will be "made available to 135 million persons." It is claimed that the provisions of this bill will not interfere with the normal rela-

tions between the patient and his physician and will not be mandatory on the medical profession. The revised bill provides for a 4% employee contribution on wages and salary up to $3,600 a year, as contrasted with $3,000 in the original bill. The 4% contribution is a reduction from 6% in the original bill. Self-employed individuals will contribute 5% of the first $3,600. State and municipal governments and their employees will contribute 2½% of the first $3,600.

The new provision that is of interest to optometry provides that persons entitled to laboratory benefits will receive such necessary laboratory or related services, supplies or commodities as the Surgeon General may determine, including chemical, bacteriologic, pathologic, diagnostic and therapeutic x-ray and related laboratory services as in the original bill. *There is then added in this new bill which was not in former bills, "refractions and other ophthalmic services furnished by a legally qualified practitioner other than a physician."* The wording of the former bill is then continued—"physical therapy, special appliances prescribed by a physician, and eyeglasses prescribed by a physician or other legalized practitioner."

The inclusion of optometry in the bill is the result of the presentation of optometry's place in the national health care program by the officers of the American Optometric Association.

H. WARD EWALT, JR.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news professional problems and ideals, as these relate to the Academy.

NEW MEMBERS OF THE ACADEMY

The following optometrists have been elected to Fellowship in the American Academy of Optometry during the quarter ending June 30, 1945. The Executive Council welcomes these new members.

Dr. Don B. Arden, Security National Bank Building, Montevideo, Minnesota.

Dr. Harold Cline, 119 West High St., Elkhart, Indiana.

Dr. Otto R. Engelmann, 5209 No. Clark St., Chicago, Illinois.

Dr. Ernest J. Giglio, 29 Olcott Square, Bernardsville, New Jersey.

Dr. John J. Hausman, 756 So. Wilton Place, Los Angeles, California.
Dr. Lorne E. Holmes, 107 4th St. S. E., Minneapolis, Minnesota.
Dr. E. Burton Hudson, 102 No. Broadway, Pitman, New Jersey.
Dr. Bernard B. Kushner, 1166 E. State St., Trenton, New Jersey.
Dr. E. E. Linke, 235 Main St., Orange, New Jersey.
Dr. George A. McEneany, 518 Cookman Ave., Asbury Park, New Jersey.
Dr. Ralph M. Marshall, 241 San Anselmo Ave., San Bruno, California.
Dr. Marshall A. Marvelli, 8213 Edwin Drive, Norfolk, Virginia.
Dr. Glenn H. Moore, 6226 No. Broadway, Chicago, Illinois.
Dr. John W. Morey, 139 Prospect St., Ridgewood, New Jersey.
Dr. T. R. Murroughs, 1222 Western Ave., South Bend, Indiana.
Dr. Arthur R. Neale, 140 Market St., Paterson, New Jersey.
Dr. Wm. H. Nicklin, 38 West State St., Trenton, New Jersey.
Dr. E. C. Nurock, 38 West State St., Trenton, New Jersey.
Dr. Alexander T. Price, 126 E. Front St., Trenton, New Jersey.
Dr. William P. Schumann, Vineland, New Jersey.
Dr. Carl F. Shepard, 5 South Wabash Ave., Chicago, Illinois.
Dr. John W. Shimek, 426 Kresge Bldg., Minneapolis, Minnesota.
Dr. Harold Simmerman, Woodbury, New Jersey.
Dr. John A. Steeve, 25 Chestnut St., East Orange, New Jersey.
Dr. E. W. Strawn, Mil. Tng. Div., OCT, 4B 607 The Pentagon, Washington, District of Columbia.
Dr. W. L. Van Osdol, 605 State Life Bldg., Indianapolis, Indiana.
Dr. Irving Weiss, 300 Main St., New Britain, Connecticut.
Dr. George Winston, U.S.S. Haven Detail, U.S.N. Med. Supply Depot, Brooklyn, New York.
Dr. John R. Wittekind, Box 5, Morrisville, Pennsylvania.

MINNESOTA CHAPTER

Minutes of meeting held June 24, 1945, 2:30 P. M., Curtis Hotel, Minneapolis, Minnesota. The meeting was called to order by Dr. Rudolph Ehrenberg, Temporary Chairman. The minutes of the April 8, 1945 meeting were read and approved. In accordance with a motion passed at the April meeting, Dr. Ehrenberg presented the Constitution and By-Laws prepared for the Minnesota Chapter by the committee appointed for this purpose. After considerable discussion, a minor amend-

ment was made to Article I, Section 4 of the By-Laws, following which the amended Constitution and By-Laws were approved.

The following officers were elected to serve until the annual meeting: Dr. Rudolph Ehrenberg, president; Dr. H. C. Sherratt, vice president; Dr. Carel C. Koch, secretary-treasurer. Drs. J. W. Shimek, H. B. Kollofski, Austin G. Engel and Walter H. Nordin were elected to serve on the Executive Council.

A date for the annual meeting was discussed and it was decided to leave the final decision in the hands of the Executive Council. A suggestion was made that the meeting be held just prior to the scheduled convention of the American Academy of Optometry in December.

By motion of Dr. Koch the Minnesota Chapter went on record as recommending the following five applicants for Fellowship in the American Academy of Optometry: Drs. Don B. Arden, Einar Markhus, Austin G. Engel, J. W. Shimek, and Lorne E. O. Holmes.

ACADEMY COMMITTEE APPOINTMENTS

Dr. J. Fred Andreae, President of the American Academy of Optometry, has appointed the following members of the Academy to the Speaker's Bureau Committee for the year 1945: Dr. Richard Feinberg, Chairman; Dr. Ernest A. Hutchinson, Dr. Lewis H. Kraskin, Dr. E. Freeman, Dr. C. A. Radde.

PUBLISHERS NOTICE—On July 1, 1945, a new postal order went into effect providing that subscriptions for Navy, Coast Guard and Marine personnel overseas must be requested in writing by the recipient. To AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY subscribers and subscription-givers this means: (1) Subscriptions entered prior to July 1, 1945, will continue to be serviced for the full term of the subscription. (2) A new or renewal subscription from an overseas serviceman *himself* is in itself a request for the magazine. (3) But a new or renewal subscription ordered by anyone other than the serviceman . . . a relative, friend, or subscription agent . . . must be accompanied by a written request from the addressee. This applies also to Christmas gift renewals. In an effort to avoid confusion when gift subscriptions are up for renewal, we suggest that readers who have entered or who wish to enter or renew subscriptions for oversays Navy, Coast Guard or Marine personnel ask for the necessary written request from overseas so they'll have it when needed.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics.
12. Miscellaneous.

4. ORTHOPTICS AND READING

STRABISMUS AND ITS CORRECTION. O. B. Nugent. Eye, Ear, Nose and Throat Monthly. 1944, 23, 4, 139-144.

The author points out that the treatment of strabismus is a delicate and painstaking procedure. He suggests orthoptics where necessary and advises his ophthalmological readers to secure a competent orthoptic technician to assist in doing this work. He strongly urges that the time to start the treatment for the correction of strabismus is immediately after it has been discovered and this is usually when the patient is very young. C. C. K.

ORTHOPTIC TREATMENT OF AMBLYOPIA. S. E. Rudlin. Associated Journal of Optometry. 1943, 8, 10, 14 and 1943, 8, 11, 14.

The author presents a modification of the flash-box technique for use in cases of amblyopia ex anopsia. Rudlin uses the Keystone Tel-Eye-Trainer. He outlines his treatment routine which he finds quite effective. A. V. F.

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7. OPHTALMIC LENSES AND MATERIAL

DEVELOPMENTS IN MAKING PLASTIC LENSES. L. Chivers. Optical Journal and Review of Optometry. 1944, 81, 18, 27.

The author describes the techniques used to make plastic spectacle lenses from a material with a trade name of Transpex. The lenses are moulded and are found to be but 5/8 the weight of glass lenses and quite transparent and hard to break. The disadvantage they have is, that they scratch easily and attempts are now being made to harden the surfaces. If these are successful, plastic spectacle lenses should find certain wide uses. C. C. K.

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12. MISCELLANEOUS

NOTES FROM AN OPTOMETRIST'S SCRAPBOOK. H. C. Roberts. Mid-West Optometric Journal. 1944, 11, 12, 14.

Every ethical means should be taken to make the public understand that fees for eye care are not established by the "price of glasses" but are based on the professional services of examining, refracting, prescribing, interpreting, verifying, fitting, re-evaluating and servicing.

T. O. B.

NUTRITION AND THE HUMAN EYE. R. M. Wilder. The Sight-Saving Review. 1944, 14, 2, 75-93.

The author discusses chronic malnutrition as a causation of degenerative disease. He finds that the eye is subject to the degenerative changes that accompany or provoke senescence, and if degenerative change can be retarded for the body as a whole, the eye assuredly will benefit. It, therefore, is not unreasonable, he believes, to suppose that application to human diets of existing knowledge of nutrition, beginning soon in childhood and continuing through life, may delay the development of presbyopia or even prevent the development of lesions such as cataract. Wilder also thinks that it may even be supposed that astigmatism, longsightedness, and shortsightedness will be found to be preventable by suitable attention to the nutrition of the maternal organism during the development of the eye of the embryo.

T. O. B.

THE OPTOMETRIC ASSISTANT. C. Croisant. The Pennsylvania Optometrist. 1945, 5, 3, 1-2.

The author reviews the qualifications required by an optometric assistant. These are as follows, the job requires an understanding of the philosophy under which the cases are analyzed, that the girl may have an insight into the visual problem of the patient; a study of psychology; a knowledge of the defenses set up, or concessions made in the seeing act; a thorough familiarity with the instrumentation and routines of actual training methods; a helpful, cheerful, sympathetic attitude; and above all an interest in and love for people, and an enthusiastic zeal for her work.

A. V. F.

THE NEW YEAR FOR OPTOMETRY. E. J. Margaretten. The Journal of the New York State Optometric Association. 1945, 12, 5, 230-231.

According to Margaretten, important changes are taking place in the American way of thinking and living. He points out that the nation of tomorrow will be a lot different from the nation of 1939. We will have new methods of doing things and new techniques and new mental approaches to our problems. He believes that optometry will keep pace with these new developments because it is young and vigorous. As optometry makes the needed adjustments, its place in the general health picture will be assured. This adjustment, however, means a full and universal practice of optometry on a professional basis. Nothing short of this will do. Margaretten points to the things which have happened in America. For instance, he reviews the changes made in the thinking of our people in the past 15 years. Ideas which were then considered radical are today looked upon as conservative and are the accepted mode of thought. Then the people rejected public health plans as being radical and not in keeping with the American way of life. Today the condition has changed. In a recent poll Margaretten points out that 68 per cent of the people favored some form of group health program and that 47 per cent were in favor of the Federal government doing the job. He points out that these changes are coming slowly but surely and that we, as well as all other professional people, must get ready to do our part properly under the post war health programs. For optometry this means that our full energies must be directed towards widespread professionalization on the part of every practitioner.

C. C. K.

PROFESSIONAL STANDARDS. F. J. Sheldon. The Kansas Optometrist. 1945, 17, 8, 4.

"Any way you look at it, your office, my office, in fact all of our offices are largely a sort of a reflection of those who are carrying on their labors within. To a great extent this is quite true, be it a 100 per cent professional office or otherwise. If you can imagine yourself as a stranger in town searching for a good optometrist, place yourself in this position the next time you approach your office. Look around it, into it, try and form an opinion of the optometrist you will expect to find in such an environment."

T. O. B.

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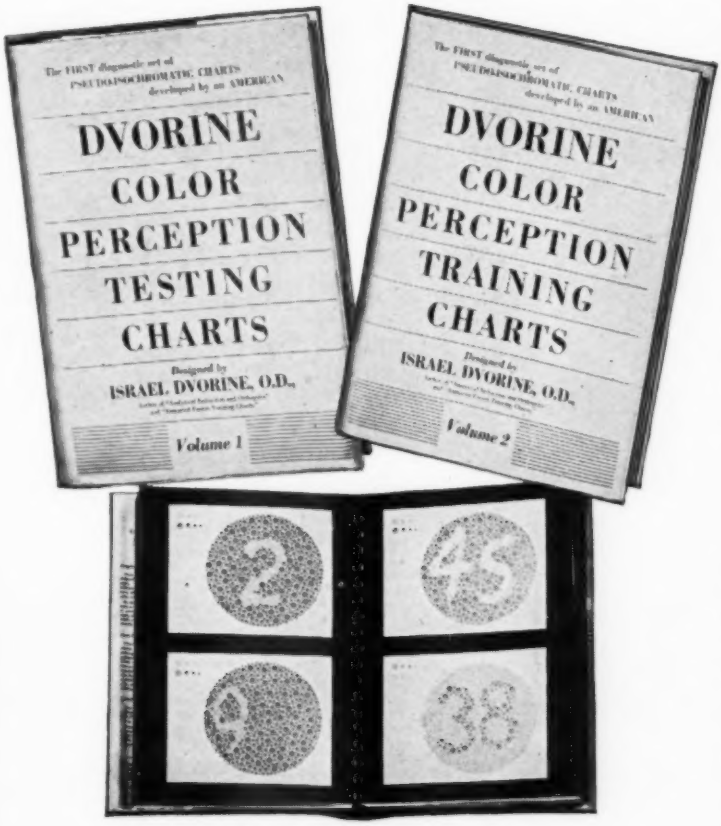

There is a growing conviction among investigators of color vision that true color-blindness is extremely rare and that the large number of partially color-blind individuals are merely confused when required to discriminate between colors of the same intensity. Many of these patients are color ignorant as well.

The sufficiently large number of patients examined and trained with the DVORINE COLOR PERCEPTION TESTING and TRAINING CHARTS justifies the opinion that a tremendous new field of professional service is opening up for the forward-looking men and women of all professions related to seeing and visual education.

POST-WAR ERA

The usefulness of these charts is not limited to the war period. At the conclusion of the war there will be a tremendous growth of interest in color perception in civilian aviation and in industry. Prepare NOW to render this new professional service.

Not "JUST ANOTHER" Color-Blind Test. This one is "DIAGNOSTIC!"

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